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Preventing Erosion of Farm Lands by Terracing[1]

By C. E. Ramser[2]

SOIL erosion is due chiefly to the free movement of water over the ground surface. If most of the rain water were absorbed by the ground upon which it falls, erosion would be greatly reduced. It is obvious, therefore, that in order to prevent or reduce erosive action, the soil must receive treatment that is conducive to the admission and the storage of large quantities of rain water, and methods must be employed to reduce the velocity and thereby the transporting and erosive power of the run-off water.

Since the storage capacity of the soil depends upon its porosity, any treatment which results in an increased porosity of the soil will reduce erosion materially. This porous condition can usually be obtained by deep plowing and the thorough incorporation of organic matter in the soil. Methods of subsurface drainage which lower the ground water level, improve the porous structure of the soil and increase its capacity to absorb surface water. The treatment of cover such as seeding land to meadow or pasture, growing timber and planting cover crops tend to check and diminish erosion. Other methods which retard the flow of the water and conduct the excessive run-off from the field with a reduced amount of erosion are subsoiling, contour plowing, and terracing.

It is the purpose of this paper to deal only with the prevention of erosion by means of terracing, but since all of the methods of prevention enumerated in the foregoing tend to mitigate the destructive effects of erosion, some of them should invariably be used in conjunction with terrace systems.

According to the earliest practice, terracing consisted of building up the surface of the land in a series of level areas resembling stair steps, the intervals between the risers being horizontal and the riser itself being vertical or nearly so. This type of terrace has long been used extensively in Europe, Asia and South America and is still being used to a considerable extent in the southeastern part of the United States. It is known generally as the bench terrace (Fig. 1). Strictly speaking this is the only true terrace, but the word "terrace" in this country is applied also to ridges of soil thrown up and located in such manner as to prevent the rapid flow of water down the slope.

The bench terrace has never become generally popular with the farmer because of the difficulty of moving farm machinery from one bench to another; the necessity of cultivating each bench separately; the loss of the land occupied by the uncultivated embankment; and the growth of weeds and grass on the embankment, which robs the adjacent cultivated soil of its plant food and tends to seed the entire field to weeds and objectionable grasses. These objections are sufficient to militate against the use of the bench terrace except on steep slopes where no form of cultivable terrace can be employed.

Since the introduction of the broad-base ridge terrace, which can be cultivated, the bench terrace has been rapidly disappearing on all lands of moderate slope. This terrace is generally known as the Mangum terrace and was originated and developed by P. H. Mangum about 45 years ago on his farm near Wake Forest, North Carolina. In Fig. 2 is shown a view of a field of Mangum or broad-base ridge terraces. These terraces are built from 15 to 25 ft. broad at the base and from 15 to 24 in. high. The entire terrace is cultivated, leaving no waste land in the field. The original Mangum terrace was built with fall along the terrace to carry off the run-off water in a broad, shallow channel at a low non-eroding velocity. In Fig. 3 is a view taken immediately after a rain showing water flowing off in a broad, shallow channel of a broad-base, graded-ridge terrace. This terrace is sometimes laid out level and the rain water that falls on the slopes between the terraces is collected and retained in the channel of the lower terrace until it evaporates, sinks into the soil, or finds its way slowly to an outlet at the end of the terrace.

In all terraced fields some washing is bound to occur on the slopes between the terraces. The richest soil particles washed from the surface of the slopes are deposited in the terrace channel. If the terrace has fall, part of this soil is carried off the field by the run-off water. From this it is apparent that a terrace should have no more fall than is absolutely necessary and where conditions will permit, it should be laid out level. The level terrace is particularly adapted for use on lands with deep, porous soils capable of absorbing large quantities of water.

The most popular and most widely-used terrace in this country is the broad-base, graded-ridge terrace; the terrace with fall. Its popularity as compared with the level terrace is due principally to the fact that it is adapted for use on most types of soil, can be spaced farther apart, and is less subject to overtopping during heavy rains. In the minds of the great majority of farmers these advantages apparently outweigh the fact that the level terrace is a greater conserver of the soil, since practically none of the soil or applied fertilizer is allowed to escape from the surface of a level-terraced field.

[1]Paper presented at the annual meeting of the American Society of Agronomy, at Washington, D. C., November, 1928. Published by permission.

[2]Drainage engineer, U. S. Department of Agriculture. Mem. A.S.A.E.

Fig. 1. Bench terraces

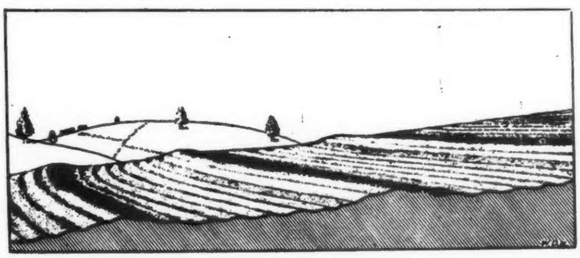


Fig. 2. Broad-ridge terraces

Fig. 3. View showing water flowing off in a broad, shallow channel of a broad-base, graded-ridge terrace

Owing to the more general use of the broad base, graded-ridge terrace, the limited length of this paper will be devoted to a discussion of the design and construction of this type of terrace. The principle involved in the design of a graded terrace is that the size and grade of the terrace channel be such that it will conduct the run-off water to a drainage outlet at a low non-eroding velocity and without the possibility of the water overtopping the terrace. The rainfall being the source of the run-off, a knowledge of the amount, intensity and duration of the rainfall is essential to the satisfactory design of a graded terrace system.

From a study of the U. S. Weather Bureau records of intense rains for short periods, the rainfall intensity curve shown in Fig. 4 was prepared. It is believed that this represents quite closely the rainfall intensities of short duration that should be employed in the design of a graded terrace. The horizontal scale in this figure represents the duration of rainfall in minutes and the vertical scale, the intensity or rate of rainfall in inches per hour. From this curve it is seen that the intensity of a rain of very short duration is considerably greater than for a comparatively long duration. For example, the rate of rainfall for a rain lasting 5 min. is 9 in. per hr. and for one lasting 15 min. is only 5 in. per hr.

The maximum rate of run-off or discharge in a terrace channel occurs when every part of the drainage area between the terraces is contributing to the discharge. This takes place when the rainfall continues during the time required for water to travel from the furthest point at the upper end of the drainage area to the lower end at the mouth of the terrace channel. This interval of time is known as the time of concentration for the terrace. From this it is seen that a short terrace with a time of concentration of 5 minutes would be designed to provide for a rate of rainfall of 9 inches per hour and a longer terrace with a time of concentration of 15 minutes, for a rate of 5 inches per hour.

The next step in the design is to estimate the percentage of rainfall that runs off or the part of the rainfall that reaches the terrace channel. This depends upon the nature of the soil, the surface cover, the slope of the land, and the intensity of the rainfall. The limited length of this paper will not permit a detailed discussion of these various factors, but an effort will be made to show that terraces should be designed for rains of maximum intensity and for a large percentage of the rainfall running off. The results of experiments by the U. S. Department of Agriculture on small agricultural areas in western Tennessee showed that for a rain falling at the rate of 3.5 inches per hour for a 12-min. period, 85 per cent of the water ran off, and for a rainfall of

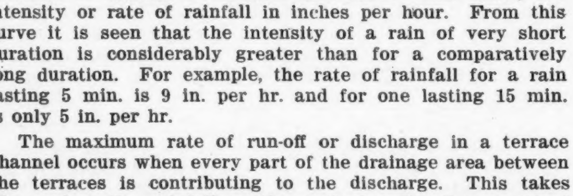


Fig. 5. Cross section of two adjacent broad-base, graded-ridge terraces

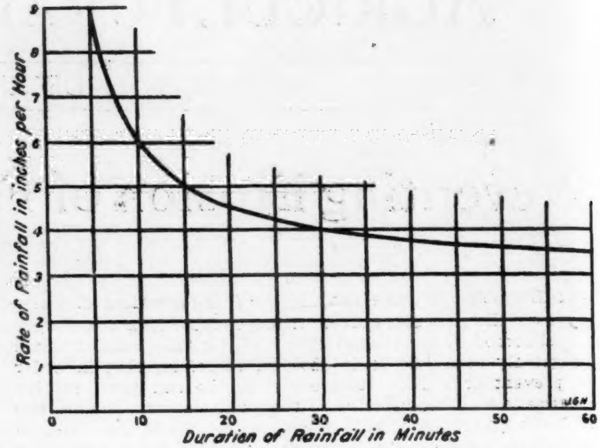


Fig. 4. Rates of rainfall for short periods for which graded terraces should be designed

1.41 inches per hour for a 17-minute period only 43 per cent ran off, all other conditions that affect run-off on the drainage area at the time of these two rains being practically the same. These measurements were made on a hilly drainage area of 112 acres devoted to the growth of corn, cotton, meadow, and timber. Some of the most badly eroded portions of the watershed were abandoned and grew up in weeds.

With reference to the amount of erosion caused by heavy rains, experiments conducted by the Missouri Agricultural Experiment Station near Columbia, Missouri, on small plots with a slope of 3.68 per cent showed that the sixteen heaviest rains out of 256 rains producing run-off during a period of 6 years caused more than 50 per cent of the erosion. Similar experiments made by the U. S. Department of Agriculture near Raleigh, North Carolina, on plots with a 9 per cent slope showed that the heaviest rains which amounted to one-tenth of all rains producing run-off caused two-thirds of the total amount of erosion.

From the foregoing it follows that terraces in order to be most effective against the ravages of erosion should be designed for the most intense rains that occur and to provide for the removal of run-off equal to a high percentage of the water from such intense rains.

An examination of many terraced fields with average soils revealed that not much noticeable erosion occurred on slopes between terraces for a vertical spacing of 3 feet on a slope of 5 feet in 100 feet, 4 feet on a slope of 10 feet in 100 feet, and 5 feet on a slope of 15 feet in 100 feet. Where the soil is extremely susceptible to erosion, it is believed that these

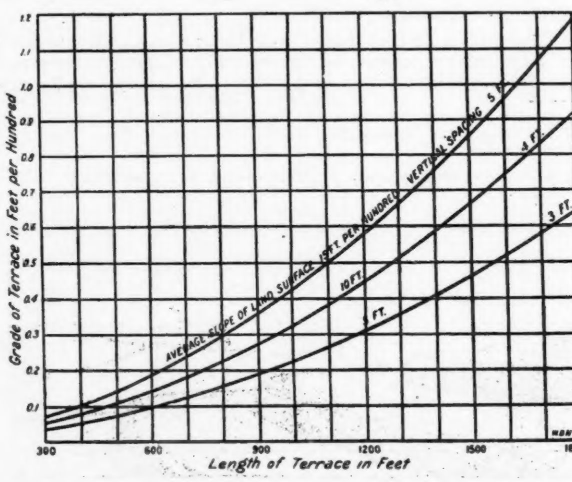


Fig. 6. Curves showing required grades for different land slopes, terrace lengths, and vertical spacings for variable-graded terraces

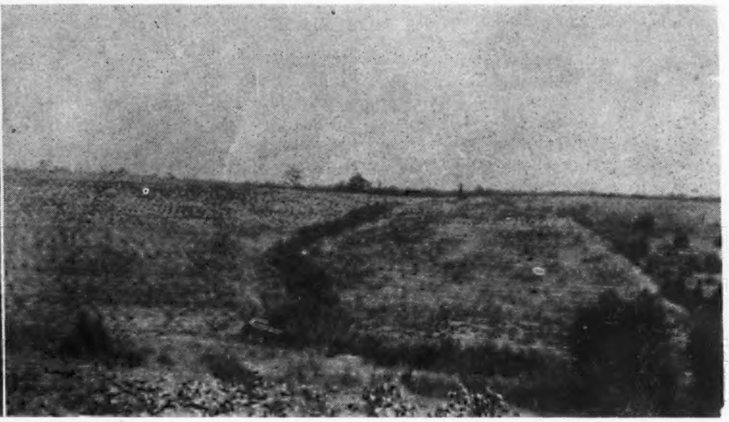
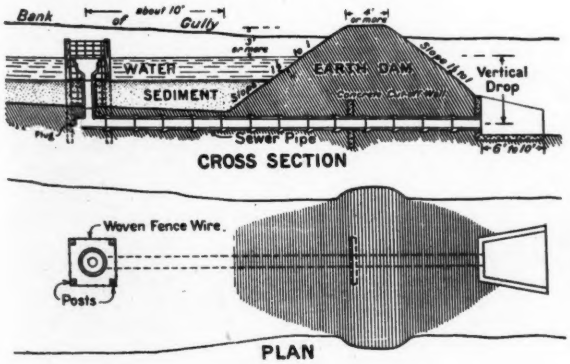


Fig. 7. (Left) Series of reinforced concrete dams built to prevent erosion in roadside ditch. Fig. 8. (Right) Terrace outlet in draw, seeded to grass to prevent erosion

spacings should be reduced one-half foot. On the other hand, if the soil contains considerable humus and is not easily eroded, the spacings should be increased one-half foot. Field examinations of a great many terraces also showed that not much erosion occurs in terrace channels where the fall does not exceed 6 inches in 100 feet. It is advisable, in designing a terrace never to exceed 6 inches in 100 feet, since the velocity of the run-off water increases with the fall and the amount of soil particles removed from the field by the run-off water increases with the velocity. The proper grade and vertical spacing of terraces are subjects worthy of careful investigations. S. H. McCrory, chief of the Division of Agricultural Engineering of the U. S. Department of Agriculture, contemplates the inauguration of such investigations in the near future.

In Fig. 5 is shown a cross-sectional drawing of two adjacent broad-base, graded-ridge terraces. The line a-b indicates how high the water in the terrace channel may rise before overtopping the terrace. The height of the terrace on a certain slope gives the channel a certain cross-sectional area and with this cross-sectional area, a certain fall is required to remove the run-off water. Hydraulic formulas based on experimental data are employed to compute the fall required for a terrace, the cross-sectional area of the channel and volume of run-off water being known, and were used in the construction of the curves shown in Fig. 6 for use in choosing the fall required for a variable-graded terrace. Variable-graded means that the fall of the terrace is increased at intervals along the terrace to accommodate the continually enlarging discharge from the increasing size of the drainage area. Such a terrace is superior to a terrace with uniform grade since it removes the water with less erosion and transportation of the soil particles, and with less liability of the terrace being overtopped near the lower end due to the piling up or concentration of the run-off water. Giving the terrace less fall near the upper end tends to store or hold back the upper water until the water below has had time to flow off.



An examination of the curves in Fig. 6 shows that the grade increases with the length of the terrace. In laying off a variable-graded terrace, a good practice is to increase the grade every 300 feet. For example, if it is desired to lay off a terrace on a 10 per cent slope, 1200 feet long and with a vertical spacing of 4 feet, then, from the middle curve in Fig. 6, the grade in feet per 100 feet would be as follows:

Station From ft.	To ft.	Grade in feet per 100 feet
0	300	0.05
300	600	0.14
600	900	0.27
900	1200	0.45

It is seen from this table and from the curve that the grade of a variable-graded terrace for the first 300 feet is small. Short terraces can be laid out practically level on any type of soil since the height of the water in the terrace channel creates sufficient fall to carry off the water.

In planning a system of terraces it is first necessary to locate suitable places for the disposal of the run-off water. Natural water courses make the best outlets. Unfortunately they are not always available since the disposal of the water is often limited to the field being terraced. In order to make the most advantageous use of natural drainage outlets and avoid the possibility of gullies developing at property lines, it is often advisable for neighboring farmers to cooperate in terracing adjoining fields.

Terraces are often made to terminate at roadside ditches. If the ditches are not protected in some way considerable washing generally occurs causing injury to the road. Erosion in roadside ditches can be prevented by means of low dams of brush, logs, rock or concrete. In Fig. 7 is shown a series of low concrete dams built in a roadside ditch to prevent erosion.

Sometimes it is found necessary to use a natural draw in a field as a terrace outlet. Where this is done the draw

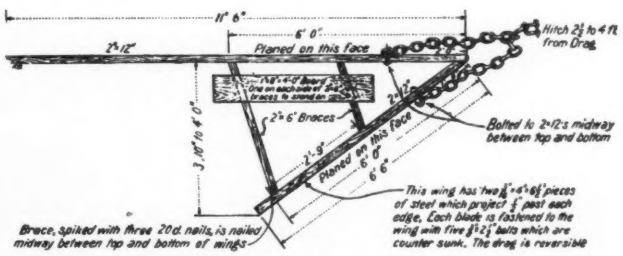


Fig. 9. (Left) Drop-inlet and earth soil-saving dam. Fig. 11. (Above) Homemade wooden V-drag widely used in the State of Texas for throwing up terraces

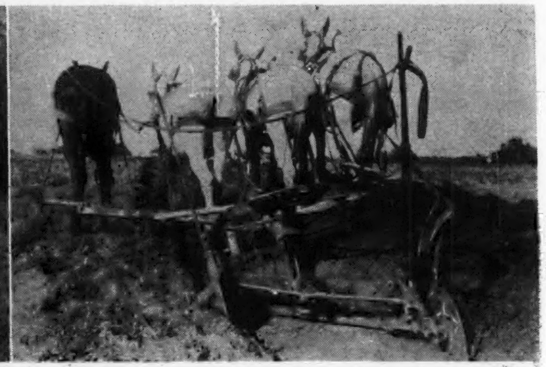


Fig. 10. (Left) Farm level and rod widely used in laying off terraces

Fig. 12. (Right) A steel ditcher and terracer

should be seeded to grass as shown in Fig. 8, or some other means should be employed to prevent the erosion of a deep gully. The soil-saving dam can be used to advantage in draws and deep gullies to prevent and check erosion. (Fig. 9). The run-off water is caught and stored above the dam, the soil particles in the water settle to the bottom and the water passes down through the vertical inlet pipe and through the dam by way of the horizontal pipe shown in Fig. 9.

In planning a system of terraces it should be remembered that a terrace is designed to remove the water from a limited area above and when this area is exceeded the stability of the terrace is endangered. A quite common cause of the failure of terrace systems is due to making the upper terrace in a field drain too large an area. As a result the upper terrace is usually broken during the first heavy rain and a large volume of water rushing down the slope breaks all terraces below. Failure to build terraces to the required height and cross section at crossings of draws and gullies is also a very common cause of breaks in terraces.

Various kinds of homemade instruments are employed in laying off terrace lines such as the A-frame with plumb bob and spirit level, but unless great care is exercised by the operator the results are invariably poor. A cheap form of spirit level, shown in Fig. 10, is widely used for laying off terraces and, in the hands of an experienced operator, very good results are obtained. The best results, however, are obtained with an engineer's level.

Implements most generally used in the construction of terraces are the plow and the V-shaped drag or steel ditcher. In Fig. 11 is a plan view of a terrace drag widely used in the State of Texas and in Fig. 12 is a view of a steel ditcher. The disk plow and the ordinary road grader are very often used in constructing terraces.

One quite common method employed in building terraces consists of backfurrowing a strip four furrows wide. The V-drag or steel ditcher is then used to move the dirt towards the center of the strip and as high as possible. The plowing is then continued and the best results are obtained where each round with the plow is followed by the V-drag or ditcher. This process is continued until the terrace is made 15 to 25 feet broad at the base. A view of a freshly built broad base terrace is shown in Fig. 13.

The old maxim, "What is worth doing at all is worth doing well," is particularly applicable to terracing work. If there is not time to terrace all of a field well it is far better to terrace the upper part properly than the whole field poorly since a break in an upper terrace results in serious damage to the field and all terraces below. Poorly terraced fields with glaring examples of bad breaks and accompanying gullies are no doubt largely responsible for the prejudice against terracing existing in the minds of many farmers.

Terraces require considerable care and attention during the first year before the loose soil has had time to settle thoroughly. All apparently weak places should be visited after every heavy rain and any breaks should be immediately repaired. It is advisable not to cultivate terraces the first year but to seed them to some sort of cover crop.

In cultivating a terrace as much of the soil as possible should be thrown toward its center. The best results are obtained where the rows are run parallel with the terrace. At first usually one row is planted on top of the terrace, but as the terrace grows broader several rows may be planted on the terrace as shown in Fig. 14. Where large machinery is used and it is difficult to follow the terrace line, the rows may be run at an angle across the terraces, if the land is not too steep as shown in Fig. 15. Where this practice is followed the terrace must be thrown up at least once a year to maintain its height.

In some sections of the country the opinion seems to prevail that successful soil conservation can be accomplished by proper farming methods and the growth of winter cover crops. In the erosion investigations formerly referred to, it was found that about 29 years would be required to wash away seven inches of soil on a bare uncultivated plot, and 56 years on a corn plot in Missouri; and 47 and 73 years, respectively, on similar plots in North Carolina. In the Missouri experiments one-half of the erosion occurred during the two months of August and September, and in North Carolina 75 per cent occurred during the summer months. F. O. Bartel, associate drainage engineer of the U. S. Depart-

Fig. 13. (Left) View of nearly completed broad-base, graded-ridge terrace. Fig. 14 (Center) Several rows of cotton growing on a broad-base ridge terrace. Fig. 15. (Right) View showing rows crossing obliquely a broad-base, graded-ridge terrace

ment of Agriculture, who conducted the experiments in North Carolina, states in his progress report that, "By far the greater amount of erosion occurs during the summer months when the land is being cultivated. The results appear to prove that any system of cover crops will be only partially effective in stopping erosion unless it is carried through the summer. In order to stop the heavy loss during the summer where cultivation is being practiced it seems evident that protection by terraces will be the only possible solution."

Terracing was first extensively practiced in the southeastern states. Since about 1915 the practice of terracing has been coming rapidly into favor in states west of the Mississippi River, and today perhaps the best terracing methods are employed in the states of Texas and Oklahoma. That terracing is regarded as important and essential to the maintenance of land values in Texas is exemplified by the following extract taken from the loan agreement of the Federal Land Bank of Houston, Texas:

"It is agreed that during the term of this loan that the land herein described shall be at all times protected from deterioration by washing or lack of drainage, by the construction and maintenance of reasonable, proper and adequate terracing and drainage, and if at any time during the period of this loan such terracing and drainage is not constructed and maintained as will fully protect said land from deterioration, of which fact the Federal Land Bank of Houston is to be the sole judge, the said bank may, at its option, declare the entire indebtedness secured hereby immediately due and payable."

Since terracing holds the soil of the farm in place and thereby both maintains its fertility and renders possible an increased fertility by proper farming methods, all of the resulting benefits such as more abundant yields and enhanced land values may be attributed directly to the practice of terracing. In short, terracing saves the soil the most substantial and valuable asset of the country.

Michigan's Farm Convenience Train

By L. F. Livingston[1]

TO MEET the problem of spreading agricultural engineering information among farmers the Agricultural Engineering Department of Michian State College cooperating with the New York Central Railroad, operated a "Farm Convenience Train." This train was similar to many others which have been run for purposes of demonstration and exhibit, except for the fact that it was entirely an agricultural engineering project, whereas in the past agricultural engineering has had to take a less important place. The aim was to answer every question of the farmer who wished to improve his place, and to stimulate the desire for improvement in those who were too well satisfied with their present inadequate equipment. To this end exhibits calculated to show the solution of typical Michigan farmers' problems were arranged in three cars.

Those who visited the train saw many things of interest, including models of a lime spreader, self-feeder for hogs, portable hog cot, brooder house, laying house, three systems of barn framing, bull pen and a correctly ventilated potato storage house.

The electrical exhibit showed a milking machine and other electrical machinery for farm use, all of which could be adjusted for use with the small lighting plants shown in action on the train. This exhibit also included a panel showing three different ways of correct wiring. Perhaps the two little rooms showing the value of light reflecting colors on walls should go in this group. The two rooms were identical except that one was painted a dull green and the other a light buff. The contrast was striking and it was hard to believe that the electric light in the buff room was not much stronger than the one in the green room.

Closely related to the electric exhibit was the one showing a number of different water systems. These ranged from the most simple, capable of being operated without electricity, up through various types of electrically operated systems, some one of which would be sure of meeting any problem likely to be found on Michigan farms. A model windmill was also shown in operation.

Besides these large exhibits there were some smaller ones which created much interest among the visitors. There was a collection of all knots and splices used on the farm. The farmer was invited to try his hand at tying them and take knots home with him if he liked. Another was the insulation exhibit showing the relative insulating qualities of various kinds of building materials. The correct hitching of four-horse teams and the correct use of concrete, with movable forms and much information about all the details of concrete construction, were also illustrated.

Of special interest to the women were the models of many conveniences for use in the farm home. Sanitary waste disposal was encouraged by showing a full-sized grease trap and a full-sized septic tank. There was a fully-equipped bathroom and kitchen to delight the eye of the fastidious housewife.

A feature of the system used in reaching the visitors who were on the train was the lecturing to those in all cars through an audio-amplification system. This proved to be effective and easy, and its advantages were so many and so obvious that it is doubtful if the lecture car system will ever be used again on this type of train.

[1]Extension agricultural engineer, Michigan State College. Mem. A.S.A.E.

(Left) The lighting plant and electrical equipment exhibit. (Right) An end of one car devoted to farm structures

(Left) The three exhibit cars of the Michigan farm convenience train. (Right) An unusual train crew, the agricultural engineers in charge of the lectures, demonstrations, and exhibits

The train made twenty-eight stops through lower Michigan and reached ten thousand interested people with its efficiency lessons. Those of the cooperators who were doubtful at first had nothing but enthusiasm for it after the tour. It seemed as though never before had there been so complete an answer to the problem of how to reach the farmer with information about the latest farm conveniences, their cost, operation, and maintenance.

The Fourth International Corn Borer Conference

By R. B. Gray[1]

THE fourth annual conference of the International European Corn Borer Organization adjourned at Toledo, September 29, after a busy two-day session. Inspection trips were made to experimental plots and laboratories where methods of combating the corn borer were being studied. Badly infested fields were visited, demonstrations of various control machines viewed, and the conference ended in a general session at the Toledo headquarters, where progress and committee reports were read.

At the laboratories various parasites were shown which attack the borer eggs or the larvae. In the experimental plots varietal tests of corn were being made, showing the effect of early and late planting and the susceptibility of various strains to borer infestation. Here also were viewed fields where cages covering a total area of two acres had been erected to screen in moths which might emerge after a good job of clean plowing. One acre had been plowed in the fall and one-half planted to corn; another acre had been plowed in the spring and one-half planted to corn. Each showed a fraction of one per cent emergence, or nearly complete control by clean plowing.

On the same farm the agricultural engineers of the corn borer control project staged a snappy demonstration of control machinery and attachments, developed and in the process of development, as well as equipment used in the 1927 clean-up campaign. Such equipment included binders equipped with a high-speed, reciprocating-knife, low-cutting attachment, developed by the manufacturers, and binders fitted with a stationary-knife low-cutting attachment devised by agricultural engineers of the corn borer control.

The first type was made up of a wide-throat, high-speed floating knife with knife speed 60 to 70 per cent greater than that of the standard binder, and a flywheel driven through an over-running clutch.

The other type was made up of a large diagonally-mounted, horizontal stationary knife, an extension-butt gatherer chain, extra throat springs and elevating shield. The stationary knife cut the corn which was elevated on the special shield. This was so constructed as to prevent the stalks from being cut a second time, but so as to permit weeds and grass to pass to the side and be cut by the regular sickle and prevent clogging.

Both of these types of low-cutting attachment performed faultlessly and cut the stalks at ground level so that the majority of borers in the stalks could be removed from the field.

Another standard binder, which left a 6-inch stubble, was equipped with a stubble slitter attachment which slashed the stubble and the contained borers. This device consisted of a frame attached to the rear frame of the binder and carried a slitter head made up of a series of sharpened blades mounted at right angles and revolving at about 500 r.p.m., or fast enough to slit the stubble into less than ⅛-inch slices.

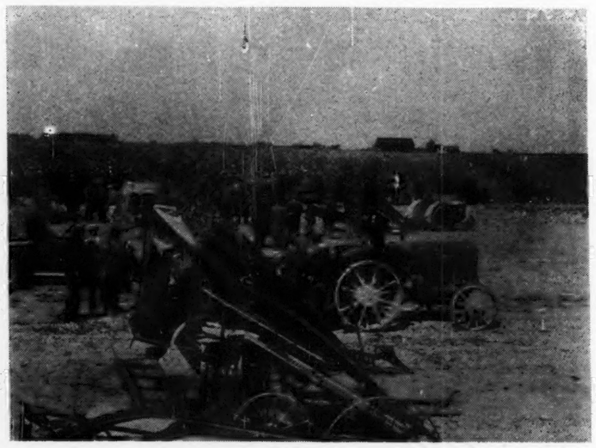
An ensilage harvester demonstrated how the standing corn could be cut at ground level, elevated into a cutter head, and chopped into half-inch lengths for the silo, thereby killing the borers in one operation.

A stubble pulverizer used in the 1927 clean-up campaign was operated to show how stubble 10 inches or less in length could be treated so that no borer could pass through alive.

The large field burner, also used in the clean-up campaign, showed how burning on a large scale could be accomplished, while the smaller mobile burner demonstrated the possibilities of a self-contained unit. This latter supplied fuel at a pump pressure of 400 pounds to nozzles with 0.028-inch orifices and produced temperatures around 1600 degrees F.

An attempt was made at plowing to show the use of special trash pans and especially wide jointers developed by the Department agricultural engineers for better trash coverage, but, owing to the hardness of the ground, this part of the program could not be carried out.

At this meeting the Committee on Corn Borer Control of the American Society of Agricultural Engineers met under the leadership of the chairman, C. O. Reed, and recommended still further work on machinery for control purposes.



A view of the field demonstrations during the fourth annual international corn borer conference at Toledo, Ohio

[1]Senior agricultural engineer, U. S. Department of Agriculture. Mem. A.S.A.E.

Some Promising Lines of Agricultural Engineering Research[1]

By R. W. Trullinger[2]

THE results of the efforts of those engaged in agricultural pursuits to get the largest possible returns for their labor and the capital invested, appear to show that the attainment of economy and efficiency in agricultural production can be materially advanced by the intelligent application of the principles of the various branches of engineering to specific agricultural practices.

Undertakings of this character, while productive of much of an immediately practical nature, have so far served to show that the engineering requirements of agriculture are, to a considerable extent, unlike those in any other industrial field, and the necessity for the development of new data and, in many cases, of entirely new engineering principles, has been strongly evident. The need is apparent, therefore, for thoroughgoing studies of several of the important and expensive agricultural operations, especially those involving the use of power and labor, to establish their full requirements and thereby provide bases for engineering developments to satisfactorily meet such requirements permanently, economically and in a fundamentally sound manner.

This would suggest that the origin of a program of research in agricultural engineering at an agricultural experiment station should lie primarily in the program of agricultural research already existing at the station. Assuming that the station program is organized as a whole to meet the needs of the agriculture of the state, it seems logical, in order to arrive at the most promising lines of agricultural engineering research which a station can undertake to determine in which of its features agricultural engineering cooperation can contribute most effectively to its ultimate specific aims. Attention is drawn in the following to a few outstanding cases of this nature which are typical of a large number observed in a first-hand study of the programs of research at a large proportion of the experiment stations during annual official visits.

CROP PRODUCTION

Crop production requires a tremendous annual expenditure of labor and power and, therefore, offers perhaps the biggest field for profitable agricultural engineering research. An analysis of all of the operations involved in the production of a crop, from the time the seedbed is first prepared and the crop planted to the time the crop is harvested and housed, will show where the power and labor is expended in the largest amounts, and should also indicate the points at which engineering studies can be inaugurated most profitably.

It is known for example, that varying with locality, from 45 to 65 per cent of the total cost of producing a crop of corn is represented by the power and labor expended in the different operations involved. In other words, the biggest expense of corn production lies in those features susceptible of modification by engineering manipulation and this seems to hold true for most of the major cultivated crops. Undoubtedly, this situation has been relieved to some extent by better management of the necessary operations and the mechanical equipment used. The fact has been brought out, however, that the methods of procedure used and the available equipment are sometimes not adequate to fully meet the actual requirements of certain necessary operations. It is also being found in some cases that the underlying physical principles of the operation involved are not fully known, and the logical conclusion is that these principles must be elucidated to permit the logical and sound development of procedure and mechanical equipment to fully meet the requirements of a necessary operation most economically.

Tillage. In corn and other row crop production, tillage for example, is one of the outstanding necessary practices which has been found in all its phases to exceed practically every other necessary operation as a consumer of labor and power. It involves the preparation of the seedbed and the cultivation of the growing crop and offers two lines of research, which appear promising especially in localities where the soils are difficult to till properly or have low tractive properties. These lines call naturally for the coordination of the forces of soil technology and agricultural engineering. They are (a) the fundamental improvement of tillage machinery so that it will satisfactorily meet the seedbed and cultivation requirements of the crop concerned with a minimum consumption of labor and power, and (b) the fundamental improvement of the traction machinery to meet the severe conditions imposed in the operation of the tillage machinery more efficiently and economically.

These lines of work have already been recognized at some of the experiment stations. The studies at the Alabama Station on the relation of the dynamic properties of the soil to the elements of tillage implement design and on the fundamental factors in soils influencing the traction of wheel tractors, are outstanding examples of work calculated to introduce economy and efficiency into soil tillage practices from both the tillage and the traction ends where the soils concerned present problems from both standpoints. They also indicate a recognition of the importance of elucidating the scientific soils principles governing tillage and traction to provide a sound basis for the development of tillage and traction methods and mechanical equipment. Equally as striking and important in this connection are the studies at the California Experiment Station of the traction obtained by the interaction of the traction members of field tractors and the soil, of air cleaners for tractor engines, of bearing wear of tractor engines as affected by the character and condition of the lubricant, and of the dynamics of field machines. The Iowa and Nebraska stations also are studying the factors involved in the draft of tillage machines with the idea of introducing greater economy and efficiency into their operation by readjustment and improvement. These studies have been inaugurated through the realization that the present methods of use of available tillage and traction machinery and, in many cases, the machines themselves, are not yet fully adequate to meet most economically and efficiently the tillage requirements of some cultivated crops in certain soils, and that efforts for their redevelopment must be fundamentally sound.

Use of Fertilizers. The use of fertilizers is one of the practices which is apparently necessary for the satisfactory production of some of the major crops. The fact that American agriculture consumes between 7 and 8 million tons of fertilizers annually suggests that this practice represents one of the big items of expense in crop production.

It seems important therefore that the most efficient use be made of fertilizers, and some of the experiment stations have pointed to proper placement of these materials in the soil as one of the major factors in this connection. The Iowa and New Jersey stations have shown already that the manner and position of placement of fertilizer materials may very materially influence its efficient use by different crops. The problem has assumed so much importance that a joint committee has been formulated representing the American Society of Agronomy, the National Fertilizer Association, the National Association of Farm Equipment Manufacturers, and the American Society of Agricultural Engineers to consider the matter.

[1]Paper presented at the 42nd annual convention of the Association of Land Grant Colleges and Universities at Washington, D. C., November, 1928.

[2]Assistant in experiment station administration (agricultural engineer), Office of Experiment Stations, U. S. Department of Agriculture. Mem. A.S.A.E.

Several recent surveys of combining practice show a need of further analytical studies of combines to point out the specific details in which their operation might be improved

It seems likely that a logical attack on this problem will necessitate a combining of the forces of agronomy and agricultural engineering to establish the requirements of proper placement of fertilizer materials for different crops, and to permit the rational development of methods and mechanical equipment which will meet these requirements. Some features of this work have already considered the physical characteristics of certain fertilizer materials under different conditions of temperature and humidity and of the mechanical means necessary for properly handling them. As a line of agricultural engineering inquiry this work, therefore, appears to be promising.

Harvesting. It is being recognized that the development of satisfactory and economical methods and equipment for the harvesting of crops calls for the coordination of the forces of agronomy and agricultural engineering. For example, work is under way in some localities on the breeding of peas and beans which will permit harvesting with available machinery. The breeding process is long, expensive, and tedious with no assurance of full success in the long run. Here it seems is an opportunity for profitable engineering effort to study the conditions and requirements for harvesting these crops, as they have been developed so far, with the aim of modifying available machines or of developing the principles of new ones which will perform this important operation satisfactorily.

A somewhat similar problem is presented in the harvesting and threshing of grain. Several stations have made surveys of combining practice recently, the results of which, in addition to serving their purpose from the farm management standpoint, have pointed to the importance of further analytical studies of available combine machines for the purpose of showing in what specific details they fall short of satisfactorily as well as economically performing some of the operations involved in the combining procedure. The Virginia and California stations, for example, have pointed out specific deficiencies in available combining machinery and are setting out to develop the specifications for fundamental improvements which will correct these deficiencies. The greater economy developed by the latter station for the bulk handling of grain, for example, suggests that efforts to secure greater economy and efficiency in specific details of the grain combining process are promising agricultural engineering undertakings.

In a similar manner the Pennsylvania station has brought to light the deficiencies of present methods and available machinery for potato harvesting from both the mechanical and economical standpoints and is setting out to correct them. The large amount of labor required for picking up dug potatoes suggests the specific features of potato digging and elevation as promising lines of engineering study. The picking and husking of the corn crop is another harvesting operation which, next to tillage, is probably the greatest consumer of labor and power of the operations involved in corn production. The mechanical performance of this operation is a great achievement in the substitution of mechanical devices for hand labor, but the Pennsylvania Experiment Station has shown that much is yet to be done toward bringing this process to a maximum of efficiency and economy.

Crop Processing. Profitable opportunities for engineering research also exist in stationary farm operations involved in crop processing. This is indicated by the progress made at the Wisconsin Experiment Station on the development of ensilage cutting and elevating methods and equipment and at the Wisconsin, Illinois, Kansas and Indiana stations on corn, hay and grain drying methods and equipment. These undertakings recognize the requirements of the finished products as determined by the agronomists and are endeavoring to meet them satisfactorily and economically with the aim of increasing the value of the crops.

ANIMAL PRODUCTION

With increasing knowledge of the relation of their surroundings to the productiveness of hogs, beef cattle, dairy stock, and poultry, it is becoming evident that housing conditions, which control temperature, air movement and supply, and humidity are important factors in the profitableness of the animal, dairy and poultry industries.

Dairy Stock. Dairy stock of different breeds are now known to present individual requirements for ventilation, temperature and humidity maintenance for maximum production. Preliminary work at one station, for example, has also indicated a relation between the quality of milk and the temperatures inside and outside the barn. Some valuable work has already been done by engineers in the development of ventilation methods and equipment for dairy barns and in the development of technique for controlling and studying air movement, temperature and humidity conditions in barns. It seems likely, however, that a closer coordination of the forces of dairy husbandry and agricultural engineering, to more clearly develop the requirements to be met in dairy barns for economical maximum quality production by dairy stock, will materially strengthen this important work. An adequate control technique seems of considerable importance in this work, and the development of this together with studies of materials and equipment to provide the conditions of air movement and temperature required appear to con-

stitute a promising line of agricultural engineering research.

Poultry Production. The housing of poultry to provide conditions for maximum economic production is presenting quite a problem. For instance, controlled studies at the Iowa Experiment Station of the air and temperature requirements of poultry have cast some doubt on the validity of previously accepted theories regarding the conditions which should prevail in poultry houses. They have shown, for example, that air purity in a poultry house is not so important a factor in the health and productiveness of poultry as are temperature and rates of air movement. Progress has already been made in this work in specifying the conditions which should prevail in poultry houses and in expressing them quantitatively.

A coordinated attack on this problem by the forces of poultry husbandry, poultry pathology, and agricultural engineering would appear to be a logical undertaking with particular reference to the establishment of the housing requirements for definite sets of conditions. The importance of an adequate control technique has already been demonstrated at the Iowa station, and the provision of this appears to be a logical function of the agricultural engineers. The fact that available engineering knowledge is not always fully adequate to permit the expression of optimum poultry house conditions in terms of usable engineering specifications would appear to argue the importance of further studies of the principles of air movement and of temperature and humidity control corresponding to these conditions. Only such studies can provide a sound and economical basis for the selection of materials and methods of construction of poultry houses and for the design of ventilating and heating equipment where needed.

CROP STORAGE

Fruit and vegetable storage has always been a problem on the farm. That present knowledge is not fully adequate to meet the storage problem is indicated by the fact that storage practice now usually allows for a certain percentage of loss in the stored products. In recent years studies of temperature and humidity conditions in existing storages have indicated quite a wide variation in the quality of the stored products with a sometimes relatively slight variation in the storage conditions. The Massachusetts and Indiana stations have shown a relation between temperature and humidity in storages and the keeping qualities of apples. Variations in the storage requirements to produce proper culinary quality has also been established in different kinds of fruit and vegetables. The Maryland station has shown, for example, that carrots and white potatoes require practically opposite conditions so far as temperature is concerned, owing to the desirability of a high sugar content in the former and a high starch content in the latter. The Montana station has shown further that there is a variation in the vitamin content of potatoes whether stored over winter in warm, dry storages or in cool, humid storages, and the Missouri station is raising a question as to the vitamin content of apples stored over winter.

It thus seems likely that a storage which is suitable for one fruit or vegetable product may be entirely inadequate for or even harmful to another product. It appears, therefore, that coordinated studies of the pathological, biochemical, nutritional, and engineering factors involved in the economic storage of fruit and vegetable products, which will establish, under controlled conditions, the storage requirements of each product and permit the development of engineering principles to adequately meet these requirements will be well worth while. The development of the control technique and of the features of the storage structures as engineering functions offer quite promising lines for research.

INSECT AND PLANT DISEASE CONTROL

The control of plant diseases and insect pests offers a problem of considerable economic importance in connection with field, vegetable and fruit crop production.

European Corn Borer. The European corn borer control work presents one of the biggest opportunities so far encountered for the development of mechanical methods in insect control and much of a generally practical nature has already been accomplished in this respect. The evidence so far available emphasizes the importance, however, of close and effective coordination of the entomological, agronomic and agricultural engineering forces engaged in the work, with the economical production of a satisfactory corn crop as the practical aim. The requirements of the crop must be considered as well as the requirements for the destruction of the corn borer, which imposes a double responsibility on the agricultural engineers engaged in the development of mechanical corn borer control methods and equipment. The field of engineering research in this connection is now being organized and clarified in the light of the available knowledge of the life history and habits of the corn borer, and appears to offer numerous profitable lines of investigation for experiment stations to which the corn borer is or may be a problem.

Curly Top Disease. The curly top disease of sugar beets is an especially important economic problem in some of the western states and it appears that the beet leaf hopper is one of the most active agents in its spread. Apparently the nature of the disease itself is not known so that efforts at preventing its spread have been centered largely on the control of the leafhopper. In this connection the idea of destroying the leaf hopper by electrocution has been developed and a study by entomologists and engineers of the electrocution requirements of this insect leading to the development of practical electrical field equipment to meet these requirements has already made some progress at one of the stations. This type of undertaking appears to offer a rather promising line of engineering investigation in localities where the curly top infestation or similar troubles are economically important.

Spraying and Dusting. In spraying and dusting work for disease and insect control, the problem is twofold, involving the difficulties of effective mixing, projecting and proper depositing of known sprays and dusts as well as the necessity for considering the item of excessive power and labor expenditure. The former has already been found to call for a rather intricate manipulation of engineering mechanics and physics which must consider the physical characteristics of the dusting and spraying materials under different conditions in connection with the mechanical requirements for their proper and effective use. The economic importance of the truck and fruit industry in many localities points to the value of engineering research which will introduce greater efficiency and economy into spraying and dusting operations.

LAND RECLAMATION

Land reclamation measures may be considered to include, among other things, such practices as drainage and irrigation. Much of a practical nature has been done in the past with available engineering knowledge by agricultural engineers in these important lines. However, the cost of drainage and irrigation practices is now assuming a position of considerable importance in the total cost of agricultural production in some localities, and the necessity for a maximum of economy and effectiveness in the methods and permanency in the structures used is quite pressing. This means that the traditional empirical and more or less standardized methods of designing and installing drains in any wet soil must give way to drainage practices based upon engineering principles carefully worked out to meet the conditions presented by individual soils. In like manner empirical irrigation practices growing out of time-honored duty of water tests, for example, must give way to methods of water application based upon the specific requirements of individual crops and soils. This conception of a profitable field of research has already led some experiment stations into undertakings which coordinate the forces of agronomy, plant physiology, soil technology, and agricultural engineering in an effort to establish the principles governing water movement, water loss and the availability of moisture to different crops, in individual soils under definite conditions. Several agricultural research institutions in Europe and South America have also recognized the economic importance of work of this character. The obvious purpose is to fully elucidate these principles and to determine how the factors involved may be most advantageously and economically influenced by the use of the hydraulic engineering principles employed in drainage

and irrigation practices. The Michigan, Minnesota, Utah and California Experiment Stations have been especially active in this work and the results so far obtained would suggest this field as being a promising one for agricultural engineering participation.

CONTROL OF SOIL EROSION

The work in soil erosion control and prevention is a field of agricultural conservation which for success has been found to require in its study a coordination of the forces of agronomy, soil technology, and agricultural engineering. Erosion is now recognized as practically an individual soil problem and engineering efforts to develop methods and structures to control or prevent it must be aimed at the characteristics and requirements of individual soils. Studies in progress on soil erosion at the Texas, Missouri and North Carolina stations have already defined some of the specific problems involved in soil erosion control. The results of this work so far, together with the statistics available as to the economic importance of erosion losses from agricultural lands, present considerable evidence that this line of work is profitable as an agricultural engineering undertaking in states where soil erosion is a problem.

FARM HOME MANAGEMENT

The comparatively recent inauguration of the national movement toward greater economy of time and labor in the operations of the farm home has brought to light a number of rather knotty problems relating to the development and use of labor-saving equipment. Much has already been accomplished in saving labor in the farm home by home management specialists. It is being realized, however, that an intelligent coordination of home management and engineering forces in the effort to introduce greater convenience, comfort and economy of time and labor into homemaking practices is likely to produce results more quickly and in a permanently satisfactory manner. Such cooperation is tending to develop the principles involved in individual operations such as cooking, laundering, cleaning, and the like, and the requirements corresponding to them which the engineer must meet either by the proper manipulation of available equipment or by the development of the specifications for new equipment. The Iowa station was one of the first to recognize the soundness and value of this procedure and to act accordingly. Work of a similar nature is now under way elsewhere, notably at the Washington and North Dakota stations. The opportunity for agricultural engineering participation seems particularly promising in this field, especially where the manipulation of mechanical or electrical principles and equipment are involved. In the development of standards and requirements for the testing of cooking, heating and laundering equipment for example, adequate control technique is necessary and its provision is an important engineering function. This together with the testing and development of equipment offers a practically new field of engineering investigation which is of considerable economic importance to the farm home.

USE OF ELECTRICITY IN AGRICULTURE

The use of electricity as a source of energy in agricultural practices has undergone considerable development during the past four years, especially since the National Committee on the Relation of Electricity to Agriculture and its auxiliary state committees have been organized. Much of a practical nature has been accomplished in those localities where electrical energy has been available.

As pointed out in a report emanating from the Office of Experiment Stations in 1924 on "Some Research Features of the Application of Electricity to Agriculture,"[3] the opportunities offered by electricity for the scientific and economic development of agriculture are so great as to demand serious and intelligent consideration. In this connection all the facts regarding the exact requirements of agricultural processes and practices must be known in order to use electricity most effectively and economically.

It has been found that features of most of the major agricultural practices have some use for electricity. This is true in features of crop production and use such as in crop processing and drying, in animal production, and especially in home management. Several of the experiment stations have identified specific problems and are now undertaking their study. Notable examples are the work at the California station on the development of electrical dairy equipment, at the Oregon station in the development of electrical poultry production equipment and at the Wisconsin and Minnesota stations on the use of electricity in the operation of stationary power machinery.

While much of this work is of rather general character it seems likely that some of the specific problems involved offer promising lines of engineering research which the experiment station can well look into.

CONCLUSION

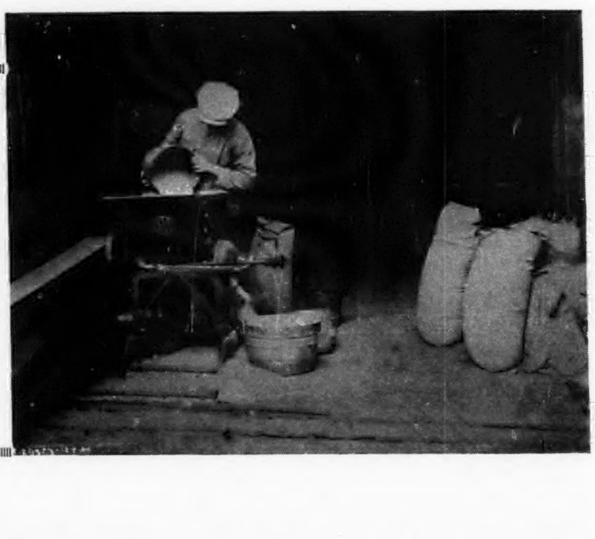
This study of experiment station work indicates that an almost unlimited field of agricultural engineering investigation much of which is quite promising in nature, lies in already existing research programs at the agricultural experiment stations. A few typical examples of such lines of work have been suggested to show their origin and nature. All of these cases are alike in that the need for engineering participation arises from some very definite agricultural problem.

Such agricultural engineering participation in the study of agricultural problems may take the form of the manipulation of engineering principles to introduce control into experiments, the testing or comparing of available equipment or the development of new equipment on the basis of known standards or established requirements, or original research to establish the fundamental principles involved in operations to provide a basis for the rational development of the necessary equipment.

Success in this work appears to call for the effective coordination of the efforts of subject-matter specialists in agriculture with those of agricultural engineers in the study of specific problems.

[3]AGRICULTURAL ENGINEERING, Vol. 5, No. 8 (August, 1924), pp. 180-185, and Vol. 5, No. 9 (September, 1924), pp. 203-208.

Many feed grinding problems, both from the standpoint of engineering and animal husbandry, have become especially important as a result of the application of electricity to agriculture and the search for an economic load.



Corn Stalks as an Industrial Raw Material

By Lionel K. Arnold[1]

A PECULIAR combination of economic conditions has been developing in the United States. Once possessing the world's greatest supply of natural timber the United States is rapidly becoming dependent upon foreign countries for much of its supply of forest products. The one time magnificent forests of the country are rapidly disappearing. More than 55 per cent of all paper consumed in the United States is imported as either wood pulp, pulp wood, or paper. This not only places us in the undesirable position of economic dependence upon foreign countries but also leaves us facing a future of still greater dependence.

The seriousness of this situation has brought forward repeated suggestions of the necessity of reforestation or some other method of solving the problem. In spite of all that has been written on the necessity of reforestation the actual amount of reforestation is still small compared with the amount of timber being used. This is shown by the fact that of the total of 745 billion cubic feet of timber, 25 billion cubic feet are used annually with an annual growth of only 6 billion cubic feet. In addition there are immense losses due to fire and disease. Even if a comprehensive reforestation plan could be put into operation at once the trees would not be large enough for utilization for forty to eighty years. Before this time the situation will be very acute.

While the country is importing great quantities of cellulosic materials in the form of lumber, paper pulp and paper, there are being wasted in the United States every year millions of tons of cellulosic material in the form of corn cobs, corn stalks, and straw. The amount of these materials available depends of course on the total acreage and the yield per acre. The former is readily calculated but the latter is dependent upon such factors as variety of grain, soil and climatic conditions, and methods of cultivation. A compilation of the various data on the yield of corn stalks as reported in the literature shows an average of 2.2 tons per acre of field dried stalks. Other results from similar sources show 2.1 tons per acre for bone dry stalks. If the stalks are allowed to stand in the field a considerable loss may occur from weathering and wind whippage. If the stalks are harvested soon after the corn is picked, it is believed that the yield in the corn belt should average 1.5 tons of dry matter to an acre. If allowed to stand in the field until spring the yield will be less, probably about 1.25 tons. This would give a total annual yield for the United States of about 150,000,000 tons. This vast amount of raw material is utilized, for the most part, in an inefficient manner. Many of the corn stalks are burned. Some are plowed under where they have a very doubtful value as fertilizer.

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Fig. 1. Shredding equipment used as the first step in transforming corn stalks into wallboard. (Photo courtesy of U. S. Bureau of Standards)

In addition to the corn stalks there are produced 20,000,000 tons of corn cobs and 70,000,000 tons of wheat, oat, and rye straw every year. These agricultural wastes constitute a supply of raw material not only of almost unlimited proportions but also of almost unlimited uses.

Another factor of economic importance is the movement from agricultural sections to cities. The gradual development towards more efficient production on the farms brought about by the extensive use of improved machinery and the application of scientific methods to agriculture has resulted in greatly increased production per individual. The decrease in prices due to the increased output has resulted in the less efficient farmers and farm workers leaving the farm. The natural movement of these farm workers is first to towns near at hand but eventually to the large industrial centers. This has a tendency to upset labor conditions in the industries so that there are in the United States unemployed from the farms in both agricultural and industrial areas.

Still another factor touching the prosperity of the American corn grower is the rapid spread of corn borer infestation. The menace of the corn borer is too well known to be discussed here. It is sufficient to remind ourselves that it is forcing the farmers to remove the corn stalks from their land and either shred or burn them. Either of these preventive measures adds expense to the already high cost of producing the corn crop.

The solution of the whole problem would be simplified immensely if it were possible by some process to convert the cellulose of the stalks and straw into a form suitable to replace the present forest products which we must import. The farmer instead of paying to dispose of his infested corn stalks would be paid for them. Factories for the conversion of the corn stalks and straw would dot the agricultural sec-

Fig. 2. The one-tone beater used in producing fibers of the desired size. (Photo courtesy of U. S. Bureau of Standards)

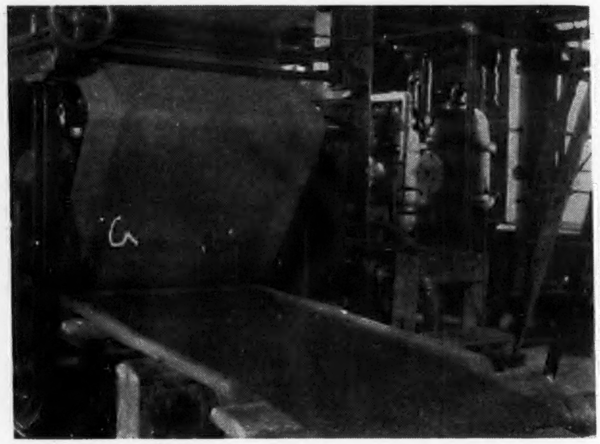


Fig. 3. (Left) A side view of the Oliver pick-up cylinder. Fig. 4. (Right) Wallboard coming from the press rolls. (Photos courtesy of U. S. Bureau of Standards)

tions bringing work near at home to the surplus labor from the farms. The industries through the agricultural regions would carry for the farmer part of his tax load and would pour into circulation more money providing greater local markets for his products. The country as a whole would be relieved from dependence upon foreign supplies of paper and lumber. Such is a glimpse of the vision that has been before Dr. O. R. Sweeney and his co-workers at Iowa State College in their attempt to utilize commercially the agricultural wastes.

A large part of the agricultural waste utilization has centered around the production of lumber substitutes from straw and corn stalks. During the last few years due to the increasing high prices of lumber there have been developed numerous lumber substitutes including various types of wall boards and plaster boards. Boards of this type have been made from a variety of materials, such as wood waste, gypsum, sugar cane waste, straw, and waste licorice root. These materials are finding an increasing use in various types of buildings. They are used, not merely as substitutes for lumber, but because they are in some respects superior to lumber. They excel in insulating properties, ease of application, sound absorption qualities, and decorative appearance.

Preliminary studies in the production of wall board from corn stalks on small scale laboratory equipment demonstrated that good wall board could be made by several methods. If the stalks are cooked with chemicals such as lime, caustic soda or other materials commonly used in paper manufacture, wall boards of varying density and strength can be secured dependent on the technical details of the process. Good wall board can also be made by a fermentation process and by a mechanical process.

The mechanical process has been developed on a large semi-commercial scale machinery during the past year in cooperation with the U. S. Bureau of Standards which has four men stationed at Iowa State College. The stalks are first shredded in a regular corn shredder (Fig. 1). The shredded stalks are then beaten about five hours in a regulation paper beater (Fig. 2) until fibers of the required size and degree of hydration are produced. About four per cent of regular paper makers' rosin size is added and precipitated onto the fibers with aluminum sulphate. Equipment being tried, in addition to the beater, for reducing the stalks to pulp, includes a swing hammer mill, buhr stone mill, attrition mills, and a large semi-commercial rod mill. While excellent pulp is produced in the beater, it is believed that it may be possible to produce equally good pulp at a lower cost with some of the other equipment now being tested.

The sized pulp is pumped to a semi-commercial Oliver board forming machine where it is formed into a continuous sheet. This machine has a screen-covered cylinder rotating in a square tank (Fig. 3). The inside of the cylinder is divided into sections which are connected to an automatic valve in such a manner that they are connected alternately to a vacuum pump and a compressed air supply. As the pulp flows onto the surface of the revolving screen much of the water is sucked on through, leaving a uniform mat of fibers on the surface. As the cylinder revolves the mat is loosened by the compressed air and stripped off by a scraper.

From the Oliver machine it passes on a continuous felt between a series of press rolls which remove more of the water and make the board more compact (Fig. 4).

The board then goes to a Coe roller dryer. Here it is carried along over a series of small iron rollers through a drying chamber heated by steam coils and provided with circulating hot air. The dried board is trimmed to desired size on a small power saw. All of the equipment used in this process is the same as used in a regular factory except that it forms a board only 28 in. wide.

This process produces an insulating type of board similar to those marketed under various trade names. The corn stalk board has an insulating value equal to that of the best boards of this type on the market. Its strength also compares favorably wth the best boards on the market. The cost of production is low, about $16 per thousand square feet. Similar boards sell on the market at about $45 per 1000 square feet.

If, instead of using the ordinary dryer, high pressure and heat are applied, a hard dense type of board is produced. For this purpose a special hydraulic press fitted with hollow steam-heated platens is used. The resulting boards are inferior to the other type as insulating material but are very hard, dense and strong. Since it has no grain this board is superior to wood where splitting must be eliminated.

In addition to producing lumber substitutes it has been shown that corn stalks can be utilized in the production of paper and of alpha cellulose for rayon. The equipment for paper research consists of a digester, beater, Jordan refiner, stuff chests, pulp screen, and sheet forming machines. Excellent paper pulp has been made from corn stalks by several of the methods used in the paper industry. The usual method is to digest the stalks under pressure in a solution of lime, caustic soda, or similar chemicals. The cooked stalks are beaten, jordaned, and screened to produce a brown paper pulp. This pulp can then be bleached out white with a solution of bleaching powder. After washing out the excess bleach the pulp is formed into small sheets on a sheet-forming machine such as is used in paper mills for making test sheets.

Three new factories utilizing agricultural wastes represent the first practical developments in this promising field. The Stewart Insoboard Company, St. Joseph, Missouri, is producing an excellent insulating type of wall board from straw while the Maizewood Products Company, Dubuque, Iowa, is producing a similar board from corn stalks. The Cornstalk Products Company, Danville, Illinois, is producing paper pulp from corn stalks.

Results of Potato Harvesting Studies[1]

By H. B. Josephson[2]

IN 1927 Pennsylvania produced 26,400,000 bushels of white potatoes and ranked fourth among the states in the production of that crop. The average yield in the state for 1927 was 120 bushels per acre, and the best growers got yields from 300 to 500 bushels per acre. To harvest this crop requires an army of people for two or three weeks each year. This transient labor is often difficult to get. In some sections the older children are released from school during the potato harvesting season, and it is common in some sections to see women in the fields picking up potatoes.

There is a real economic need for labor-saving machinery in potato harvesting. Results of studies at the Pennsylvania Agricultural Experiment Station show that from 42 to 54 per cent of the man labor required in producing a crop of potatoes (up to time of grading) is used in harvesting. Picking, which is entirely a hand operation, takes from 26 to 33 per cent of the total man labor of producing the crop[3]. The lower figures are for common Pennsylvania practices while the higher figures were obtained when power machinery was used to reduce man labor in many operations other than picking.

Two men, with modern equipment, can easily take care of 30 acres of potatoes up to the time of harvesting, except for some extra help at planting time for cutting seed. This help is often supplied by the family. To harvest the crop in an average season, these men require the help of six additional men for two or three weeks.

Common Harvesting Methods. The elevator digger is used by all the better growers of the state. After the potatoes are laid on top of the ground with an elevator digger about one-third of the labor in producing the crop is yet to be done. This includes picking and hauling to place of storage. Picking is the next job and this is entirely a hand operation. To stoop down and pick potatoes off the ground all day is a tiresome and disagreeable job. Human beings do not naturally work in such a position, and to be compelled to do so would seem to be somewhat of a reversion to primeval habits. Certainly our methods of harvesting the potato crop have not kept pace with other processes on the farm.

The best growers have found that picking in one-bushel crates is a more convenient and efficient method than picking in baskets or pails and emptying these directly into sacks or a wagon driven along the rows. Every alternate row is lifted with the elevator digger. Adjacent rows cannot be dug with the ordinary one-row machine. Fig. 1 shows a common method of picking in crates. Two men working together pick one row each keeping the crate between them.

When the crates are scattered along the rows in advance each picker will fill, on an average, eighty-five crates per day, each crate holding one bushel. The rate of picking depends upon how well the soil is separated from the potatoes, and more work can be done in a heavy crop than a light one. Some pickers are hired by the day, others pick by the bushel. The daily wage in the fall of 1928 was about \$3.50 per day, without board, and the rate per bushel for picking was 5 cents.

Elevator Diggers. The elevator digger is the only machine that has, so far, played an important part in harvesting the potato crop in Pennsylvania. A good digger facilitates the process of picking up the potatoes. From the standpoint of quality of work done thorough separation of the potatoes from the soil and vines is the first consideration. The difficulty of obtaining good separation is bringing the engine digger into favor. An engine of 4 hp. or more is mounted on the digger to drive the elevating and separating mechanism. This decreases the draft on the team and two horses pull the machine without difficulty. By driving the team very slowly the digger is given more time for separation and a better job is done.

Fig. 2 shows an elevator digger driven by a four-cylinder automobile engine. During the spraying season this engine is used to drive the pump on the potato sprayer. This digger differs from the ordinary digger in the width of tread. The ordinary digger straddles but one row; the wheels of this digger straddle three rows. The advantage is that the machine works much steadier on hillsides. The ordinary engine digger has a tendency to be top-heavy. This lack of stability makes it unsafe to use on extreme side slopes and makes it creep down hill on moderate side slopes so that it is difficult to keep on the row. Another advantage of the wide tread is that no damage is done by the wheels to the potatoes that are spilt from the side of the elevator. Too often these stray potatoes are crushed by the wheels.

The power take-off provides a very satisfactory method of driving the mechanism when a tractor is used for pulling the digger. Fig. 3 shows a two-row digger driven with power take-off. Some growers favor the idea of using two-row diggers as two adjacent rows can then be dug, the claim being that it is an advantage to the pickers to work from adjacent rows. Only a very few two-row diggers have been sold in the state, and although some labor is saved in dig-

[1]Last of a series of six articles based on the results of a power and labor research study at the Pennsylvania State College. First publication in AGRICULTURAL ENGINEERING authorized by the director of the Pennsylvania Agricultural Experiment Station, as technical paper No. 460.

[2]Agricultural engineer in charge of farm machinery research, Pennsylvania State College. Mem. A.S.A.E.

[3]AGRICULTURAL ENGINEERING, Vol. 9, No. 7 (July, 1928).

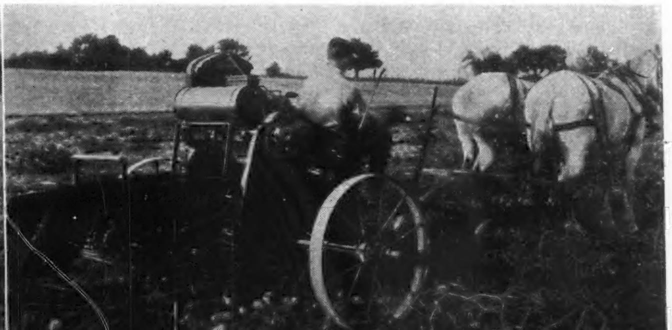


Fig. 1. (Left) Picking up potatoes. There is a real need for labor-saving machinery in potato harvesting. Picking, which is now entirely a hand operation, takes from 26 to 33 per cent of the total labor of handling the crop. Fig. 2. (Right) An elevator digger with engine drive


Fig. 3. (Left) A two-row potato digger driven through power take-off from the tractor. Fig. 4. (Right) One of the few mechanical potato pickers that operated in Pennsylvania this season (1928)

ging, the picking situation will not be helped materially by their adoption.

Mechanical Pickers. The nature of the soil in the most important potato growing sections of Pennsylvania makes it impossible to use the mechanical pickers now on the market to advantage. Two conditions contribute to this difficulty. The soil, which in most sections is a clay loam, does not break up easily but is carried in a cloddy condition over the elevator digger. Stones also hinder the used of the mechanical picker. On many fields there are as many small stones as potatoes contained in the soil slice that is lifted by the elevator digger. A number of mechanical pickers have been tried in various parts of the state. Fig. 4 shows one of the few pickers that was operating in Pennsylvania this season. The digger was driven by an engine mounted on the frame while the picker was driven by traction through its own wheels. The tractor was driven in low gear and throttled down to a low engine speed. The crop was light and soil conditions most favorable.

The mechanical pickers now on the market provide for two or more men to ride on the machine to pick stones, ground clods and vines from the potatoes which pass over the elevator into sacks (Fig. 4). If the conditions are such that the soil is completely separated from the potatoes, the ground not stony, and the crop light, this mehod is entirely feasible. In Pennsylvania such conditions rarely exist.

Another method, adopted by one picker manufacturer, is to let the men pick the potatoes from the soil and vines. This method would seem to be more feasible under our soil conditions. Although not so dependent upon thorough soil separation, this method is feasible only in very light yields at the speeds which the machine is ordinarily made to travel. Speeds of less than 1½ miles per hour are difficult to secure either with teams or the modern tractor.

A modification of the mechanical pickers now on the market may be the key to solving the problem in Pennsylvania even though the present machine has failed.

Suggested Changes in Pickers. Difficulty in securing separation together with heavy yields are the main reasons for the failure of the present potato picker in Pennsylvania. A slower speed would help to meet both these conditions.

No attempt has been made to operate potato pickers at speeds slower than that obtained with tractors driven in low gear and throttled down to a low engine speed. This would give a minimum speed of about 1 mile per hour.

In a yield of 300 bushels per acre (which is common among the better growers) and with rows spaced 32 inches apart, the machine would handle 96 bushels of potatoes per hour when traveling at the rate of one mile per hour. Four men working on the picker would then have to pick at the rate of 24 bushels each per hour. This is much faster than a man can be expected to work. A good picker can, for a short period, pick at the rate of 15 bushels per hour when picking off the ground in the usual way. A good average is 10 bushels per hour. Probably 15 bushels per hour is all that the pickers could be expected to do when working on the machine. Four men would then pick 60 bushels per hour and the machine should travel at about 0.62 miles per hour in a yield of 300 bushels per acre. A speed as low as ½ mile per hour would be necessary in high yields.

Picking Potatoes from Bunches. It has been found easier to pick potatoes from small bunches or piles than from continuous rows. When the potatoes are placed in piles the picker can stoop down and pick a bushel or so in one position or he can kneel down and save bending his back. This method has its limitations when the ground is very cloddy or when there are too many stones. However, it promises to have possibilities in many sections of Pennsylvania.

One of the farm equipment manufacturers in the East is developing a machine with hopes of securing a sufficiently complete separation to put the potatoes in piles of one-half bushel or more.

SUMMARY

1. Harvesting takes from 42 to 54 per cent of the total labor required in producing the potato crop. Picking up the potatoes, which is now entirely a hand operation, takes from 26 to 33 per cent of the labor required in producing the crop.

2. The average man picking potatoes in crates gathers up 85 bushels per day.

3. Pickers were paid $3.50 per day, or 5 cents per bushel in the fall of 1928.

4. Engine-driven potato diggers are gaining in favor because they do better work than traction-driven diggers.

5. Mechanical pickers have not been found satisfactory under Pennsylvania conditions. Their failure is attributed to the difficulty of securing good soil separation, presence of stones, and heavy yields.

6. Lower forward speeds seem necessary in our high yields, if mechanical potato pickers are to be used.

7. Picking from bunches has been found easier than picking from continuous rows and mechanical equipment is being developed that will place the potatoes in bunches of one-half bushels or more and thereby facilitate picking.

Plumbing Standardization

ACTION to improve plumbing materials and eliminate the present difficulty of matching worn out plumbing equipment, is now under way under the auspices of the American Standards Association. The sectional and subcommittee organization is practically complete and good headway is being made in the most important branches of the work.

The American Society of Mechanical Engineers and the American Society of Sanitary Engineering jointly head the sectional committee. Four subcommittees have been organized under the Division of Simplified Practice of the Department of Commerce. They cover "Minimum Requirements for Plumbing in Dwellings and Similar Buildings," "Staple Vitreous China Plumbing Fixtures," "Staple Porcelain (all clay) Plumbing Fixtures," and "Enameled Sanitary Ware."

Dairy Equipment Sterilization with Electricity[1]

THE Committee on Dairy Equipment Sterilizers of the American Society of Agricultural Engineers, which was appointed in the fall of 1927, reports as follows regarding its work during the year 1927-28.

The work was divided into several parts, covering bacteriological studies, survey of dairy laws in certain states in regard to sterilization, tests of various types of dairy sterilizers, publishing data and outlining work of committee for coming year.

Present Status. The present status of the dairy sterilizer situation seems to be that sterilization is required in only one state (California) but is recommended by various authorities in other states. Sterilizers are in actual use to a considerable extent in certain parts of California and Washington, and it seems to be only a question of time in many states until practically all dairies, producing market milk will be required to sterilize their equipment. The demand for better quality of milk has caused many farmers to sterilize as an aid in increasing the quality of milk and as an insurance against loss by souring or low grade. It is sometimes difficult to determine just when a sterilizer is a paying investment in dollars and cents, because sometimes a farmer is not paid any more for a good quality milk than he is for poor quality; under such circumstances it hardly seems justifiable to sterilize except for the personal satisfaction he may have in producing a superior product or the saving due to prevention of souring of milk. Saving only two or three batches will often pay for his sterilizer.

[1]Report of the Committee on Dairy Equipment Sterilizers presented at the Rural Electric session of the 22nd annual meeting of the American Society of Agricultural Engineers, at Washington, D. C., June, 1928.

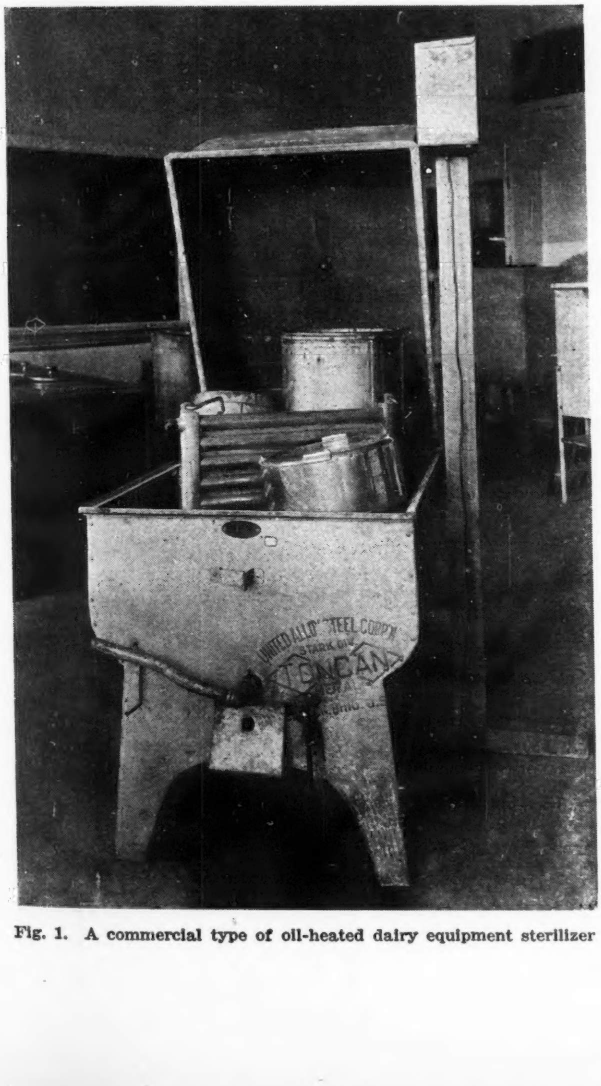


Fig. 1. A commercial type of oil-heated dairy equipment sterilizer

Apparatus and Methods. The small farmer who has only a few utensils to sterilize, usually does this by scalding with hot water, although he may use a small tank type sterilizer which he sets on the kitchen stove or over a special oil stove used for the purpose.

The larger dairyman who perhaps has a considerable amount of equipment to sterilize, has a special milk house equipped with a wash tank and a tank type sterilizer large enough to hold the utensils. The sterilizer may be heated by an oil burner, a coal or wood fire, or by electricity. There is one manufacturer who makes a combination wash tank and sterilizer which is used quite extensively in California. The steam boiler and closed tank outfit is nearly always used in the larger sizes, since many dairymen desire steam under pressure, which allows them to sterilize milk coolers in place and also gives them higher temperatures with resulting quicker sterilization.

Most of the dairymen use galvanized iron for the sterilizer box proper, but some have used wooden boxes lined with galvanized iron, and some have used concrete. The latter requires a large amount of steam and is, therefore, rather expensive to operate.

Some dairymen sterilize by steaming over a jet but this is a very uncertain method unless care is taken to see that all surfaces of equipment are properly brought in contact with the steam. It allows the entrance of the human element more than other methods and is, therefore, not looked upon with favor by many dairy authorities.

The temperature requirements vary, but the California law requires 170 deg. F. for 15 min. and the University has recommended 20 min. at 210 deg. F. for severe cases, when steam is used. Ayers and Mudge (U.S.D.A.) state that the proper time and temperature when using hot air is 230 deg. F. for 30 min.

Some of the objections and difficulties encountered with oil-heated sterilizers are short life, sooty and unsatisfactory burners, and excessive cost of operation. The principal difficulties of electrically heated sterilizers are their high first cost, high cost of operation in all except localities where electricity may be had at low prices, and danger of burning out elements, with resulting high cost of replacement.

The hot air type sterilizer is perhaps in more of an experimental stage just now than any other type but it also seems to offer the greatest possibilities from the standpoint of electrical heating. It requires only a small heating element which is not likely to burn out; it is practically foolproof, and it has shown very good bacterial reduction in preliminary tests at California. It leaves the equipment dry after sterilization, thus decreasing the rusting of utensils. Some of the disadvantages are unevenness of heating and lack of penetration of heat in equipment not thoroughly cleaned.

Prof. Hastings of the bacteriological department, University of Wisconsin, who has done considerable work on sterilization, believes that dry air will prove the more efficient from a bacteriological standpoint. His contention is that following a thorough washing, very few bacteria remain in an utensil, and if the utensil be thoroughly dried, bacterial growth is stopped and the final results will be the same as when steam is used.

The problem of water heating is closely linked with that of sterilization and the two should be worked out together. Some types of sterilizers are so made that they can be used for heating water. Where the hot air type sterilizer is used it would be necessary for a small auxiliary water heater to be installed, perhaps on a double-throw switch with the sterilizer so that the demand charge would be small.

One of the principal difficulties met with in the use of electric sterilizers is that electricity must also be used for heating water. This is expensive in many places where

electricity is high. It seems desirable to work out a system in certain parts of the country where solar heat could be utilized for this purpose during a considerable part of the year.

Although there are many electric sterilizers in successful use at the present time, it seems that before they can become popular in many parts of the country, where sterilization is not required and where electric rates are high, it will be necessary to develop a simple, dependable, inexpensive sterilizer, perhaps of the hot air type, and make adjustment of rates which will allow of economical heating of water.

The use of electric dairy sterilizers has become quite common in California, and it is estimated that there are from eight hundred to nine hundred in use at the present time. This is made possible by quite favorable electric rates and the fact that the sterilizer load is not the determining factor in the demand charge. Many dairies have large motors for driving pumps which absorb this charge. Sterilization is required in California.

Some trouble has been experienced with automatic devices and at the present time hand operation seems to be the most popular, partly because of the lower first cost. Thermostats and time switches have been successfully used, however. Some trouble has been experienced with heating elements burning out. It is suggested that lower wattage per unit area of heating surface, or some method for preventing heating elements from burning out should be employed. There have been cases of thermostats failing to operate at high elevations in the mountains where the boiling point of the water was lower than the setting of the thermostat. The first cost of sterilizer and heating elements is rather high and it would be very desirable to reduce this. Most of the present electric sterilizers sell for from $55 to $125. There seems to be no difficulty in obtaining good bacteriological results, providing the temperatures are maintained properly.

It is necessary for the farmer to use warm water in cleaning his equipment. Therefore, the sterilizer should be so made that it can be used for heating water as well as sterilizing, or a small continuous heating element and separate water heating tank should be provided. This latter would be necessary if a sterilizer of the hot air type were used.

Experiences in Oregon according to Geo. W. Kable[2] were that the equipment performed satisfactorily from the standpoint of sterilization but not for water heating on account of excessive cost of electricity. Experiments with attaching a 5-kw-hr. heater to a wash tub were not satisfactory because this provided no reserve supply of hot water for rinsing.

One of the difficulties met with in all of the steam type sterilizers is rusting of equipment if it is left in the sterilizer. It is, therefore, recommended that utensils be removed from the sterilizer while yet hot in order that they will dry off properly by evaporation. With certain types of sterilizers the water can all be drained off and a vent on top opened to remove the moisture. It is thought better, however, to remove the utensils entirely from the sterilizer and drain the water out of them. Dry utensils do not rust or promote the growth of bacteria.

Experiments are being tried in Washington by J. C. Scott[3] in which a wooden barrel is being fitted with a 750-watt heater, a description of which is furnished as follows by Kable quoting from a letter received from Mr. Scott:

"A farmer named Sikes took a wooden barrel, put an insert 750-watt heater about 2 in. from the bottom, placed a false bottom about 6 in. above the heater, and put a faucet in where it would draw the water off to a line just under the false bottom. The false bottom is, of course, made of slats or perforated so that water can go through. The top of the wooden barrel should be lined underneath with copper, but should be wood on the outside.

"We are now trying to get these barrels insulated because the heater is so much more efficient than the insulation. The insulation consists of asbestos wrapping with a covering over the asbestos which is painted so it can be washed off.

"We have a flat water heating rate here of $3 per month for a 750-watt heater. The heater is left on 24 hr. of the day. After the utensils are washed, they are placed in the barrel on the false bottom, the lid is put over them and they are left there until the next milking, by which time they have been thoroughly sterilized. When the milker goes out to milk he takes the utensils out of the barrel, puts 10 or 15 gal. of cold water into the barrel, and when he has finished milking he draws this water off (which is plenty hot enough for washing), leaving water enough in the bottom of the barrel for sterilizing again.

"I found one of our customers using this simple arrangement and he was keeping his bacteria count very low. I took the state dairy inspector out to see it, and he is so enthusiastic about its possibilities that he is recommending it to dairymen and dairy organizations. One of our largest creameries here in town (Seattle) is figuring on making them up and putting them out to their farmers at cost.

"The principal thing about this sterilizer water heater is its low first cost and low operating cost.

"The milk inspection department of the city of Seattle are very favorable towards it and are recommending it.

" . . . . present indications are that a sterilizer will work out of this whole propositoin that will be more popular than anything that has ever been devised, on account of the very low rate and the low first cost.

"We are making such rapid progress in the development of this sterilizer that even now the ones that are being made up do not resemble the first ones used, although the basic principle is the same.

"Hindman & Shippe, 401 E. 45th St., Seattle, are doing a great deal in improving this sterilizer, and the last one that I saw is copper-lined, well-insulated sheet metal on the outside with insulation between. The heater is of a patented percolating system as used in their steam tables, and has been very successful. With our flat water heating rate of $4 per kw. per month, it is necessary to put a thermostat in the heater. You might think that this arrangement is running into considerable money, but they are already getting out sterilizers, well insulated and with thermostats, that will cost from $30 to $35 retail."

Bacteriological Studies. C. S. Mudge[4] reports as follows on the sterilization of dairy equipment from the bacteriological standpoint:

The importance of bacteria to the dairy industry can not be overemphasized. It would not be a misstatement to say that the rise of the dairy industry has been possible largely through our increased knowledge of the bacteria found in milk. The magnitude of the dairyman's troubles are inversely proportional to the number of bacteria found in milk, for the more bacteria are kept out of the milk as produced and the more the bacteria are kept from growing when they do find their way into the milk, the better are the milk supplies and the fewer the problems that arise.

There are five types of bacteria in milk as measured by the effect they have on it. They are the acid, acid coagulation, inert, alkali, and peptonizing. The first two groups give the dairyman very little trouble; in fact, he has learned to use them to a large extent in making cheese and butter. The alkali and inert types are of little importance according to our present knowledge. The peptonizing bacteria are usually the organisms which cause the dairyman most of the trouble. These bacteria change the casein of milk to a soluble, bitter, often putrid, condition, which causes bad odors and flavors in the milk.

The solution of the problem of the dairy sterilizer is largely the solution of the problem of destroying these peptonizers because for the most part they are spore forming organisms, which means that they can better resist heat and chemicals than bacteria generally.

A survey of the dairy laws of the various states would reveal a rather interesting fact. Without exception two things are stressed above all others. Clean barns, clean cows, white uniforms are all of great importance, but the outstanding features of all laws are (1) sterilization of utensils and (2) cooling of the milk. Neither can be said to be more important than the other. Both are necessary if a good milk supply is to be maintained.

An experiment reported in U. S. Department of Agriculture Bulletin No. 642 bears out this fact better than has ever been done before. Cows were maintained under the dirtiest conditions imaginable. Many samples of milk were analyzed over a long period of time, these samples averaging 500,000 bacteria per cubic centimeter. Simply by adequate sterilization of the utensils, even while keeping the other conditions as dirty as possible, the count dropped from 500,000 to 20,000. This difference in count represents solely the effect of sterilization of utensils. When utensils are dirty, the film of milk which clings to the inside wall is teeming with organisms. The addition of fresh milk to such a utensil causes this film to loosen and to be incorporated with the added milk, thus inocculating it with count-

[2]Agricultural engineer, Oregon Agricultural Experiment Station. Mem. A.S.A.E.

[3]Agricultural engineer, Puget Sound Power & Light Co. Mem. A.S.A.E.

[4]Department of dairying, University of California.

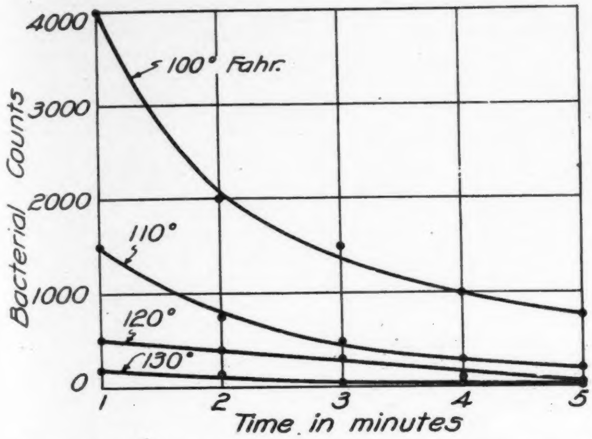


Fig. 2. Curves showing the effects of time and temperature on bacterial destruction

less thousands of organisms, which, incidentally, are usually of the least desirable sort, the peptonizers mentioned above.

This is true because as the above-mentioned film dries on the can, the more desirable acid-forming bacteria die, leaving the resistant spore-forming, peptonizing bacteria which rot milk.

The numbers of bacteria that can be found in dirty utensils run into the millions, and it is possible to add 500,000 bacteria for each cubic centimeter of fresh milk added to such utensils. Furthermore, these dirty utensils contain the undesirable peptonizers mentioned above, as Table I will show. It will be seen from this table that the milk fresh from the udder has very few peptonizers, while the unsterilized utensils have them in great profusion.

The bacteria found in the utensils can be killed by sterilization. It is not sterilization in the absolute sense, however. The dairyman speaks of a "sterile" can only in a relative sense. It is quite impossible to kill all of the bacteria in a can by the farm methods, for to kill the last few organisms would take temperatures and pressures above those at the command of the dairyman. An efficiency of 99 per cent killed is all that can be expected.

The killing of bacteria by heat involves hydrolysis, a chemical reaction resulting in the coagulation of the cell protoplasms. This coagulation is dependent upon time and temperature, and as with all lethal processes, there is a definite proportion between the living cells and remaining dead cells at a given time. The curve drawn from data gathered in a study of germicidal action of heat or of chemicals is a smooth curve as is shown in Fig. 2, where the surviving bacteria are shown as ordinates against the time factor. The effect of temperature is also noted. This figure was taken from published data gathered by the author in some studies upon the action of alkalies on bacteria.

The methods used for the estimation of the number of bacteria in milk cans may be of interest. A liter of sterile water is poured into the can. The cover is placed in position and the can shaken vigorously fifteen or twenty times. This wash water is then poured back into the original container, and a cubic centimeter of this water is plated. The process of plating, briefly, is the mixing of a known amount of the bacteria-containing material with a gelatin-like substance containing nutrient. The bacteria are held in place by the gelatin, but grow profusely, forming spots or colonies visible to the naked eye. Fig. 3 shows some colonies. After

TABLE I

Source of Sample	Acid coagulating	Acid	Alkali	Peptonizing
	per cent	per cent	per cent	per cent
Udder	46.20	37.2	0.45	6.3
Milk from sterilized utensils	25.80	39.2	0.71	8.6
Milk from unsterilized utensils	11.54	16.9	14.10	25.7
Washings from unsterilized cans	0.39	1.8	19.20	66.8

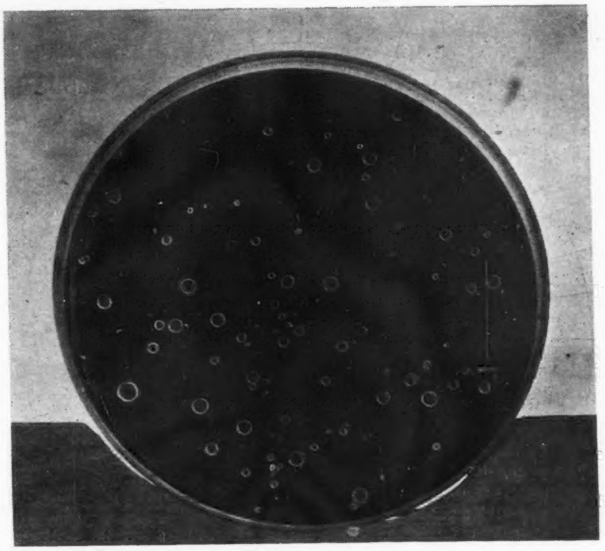


Fig. 3. Colonies of bacteria after forty-eight hours growth, from which the "official plate count" is taken

a growth period of forty-eight hours the colonies are counted and recorded as the "official plate count."

One thousand cubic centimeters are usually employed in washing cans but other amounts can be used. The results are reported as bacteria per can, which is obtained by multiplying the colonies found in the amount of wash water used in the plate by the total added to the can. There is no standard procedure.

A thorough knowledge of the engineering principles involved in such a simple apparatus as a farm sterilizer is lacking, and a field of endeavor is thus opened to the engineer.

Economics of Dairy Sterilization. Geo. W. Kable reports as follows on the need of an economic study of dairy equipment sterilizers:

Granting that dairy equipment sterilizers are desirable from the standpoint of sanitation and high quality dairy products, the average dairyman also demands economic justification for the purchase of new equipment.

An economic study of electric dairy sterilizers naturally divides itself into two major parts:

1. A comparative study with other types of sterilizers in localities where sterilization is required.
2. Increased money returns due to the production of a better commodity in localities where sterilization is not compulsory. In either of these cases we must consider existing power rates, especially flat heating rates. and also whether or not the sterilizer constitutes the primary load which will govern the service or minimum charge.

The first part of this study, and particularly where the sterilizer does not constitute the primary farm load, has been worked out reasonably well in California and some other states. The result has been the rather widespread adoption of electric sterilizers in place of other types.

In localities where sterilization may be desirable but not compulsory, the problem is not so near a solution. There is some likelihood that equipment of different design must be devised before electric sterilization will become popular or practical. The following instance is more or less typical of this situation.

A 5-kw., partially insulated sterilizer was installed at the Astoria Experiment Station in Oregon. Records of power consumption and cost for sterilization only were kept for the three months of October, November and December. The total power consumed during this period was 131 kw-hr. costing $29.07. This is obviously unreasonable, but nevertheless typical of metered rates. The cost was made up of a $25.14 service charge and a $3.93 power charge at 3 cents per kilowatt-hours. The station superintendent was not well pleased with the sterilizer arrangement for heating wash water because there was no hot water available for rinsing.

When the sterilizer was used for heating water the cost was 6.6 cents for heating 7 gallons from 60 to 180 deg. F. with the cover on and 11.7 cents with the cover off, at 3 cents per kilowatt-hour.

We do not interpret this as meaning that electric sterilization will not be feasible in such territory. It does mean that further study of sterilization methods, sterilizer design and sizes and the effect of insulation on operating cost is needed. The power companies must also scrutinize and revise their rate structures if they want this business, and the equipment companies and educational agencies should find other companion uses which will help absorb the minimum charges.

Tests of Dairy Sterilizers. Two agricultural experiment stations—Washington and California—reported detailed tests conducted on sterilizers, the Washington experiment covering small 5 and 3-kw. sterilizers and the California experiment covering a 15-kw. outfit.

The data on the Washington tests are as follows:

A Wellman Brothers electric sterilizer was secured and installed at a local dairy farm. The farmer pays half of the power bill and the Washington Committee on the Relation of Electricity to Agriculture half. This sterilizer is worked in conjunction with a hot water tank equipped with a 1000-watt heater. A 5000-watt heater is used on the sterilizer. No overheat control is supplied with the sterilizer nor its heating element, making it necessary for the operator to keep a constant watch on the water, filling the sterilizer every day or oftener, if several heats are to be made. The water is taken from the hot water tank at temperatures ranging between 90 and 120 deg. F. and placed in the sterilizer. The sterilizer then raises the temperature of the water only from the temperature of the hot water tank to the boiling point. The 5000-watt heater was turned on on one occasion without any water in the sterilizer and quickly burned out. A 3000-watt heater was used until the 5000-watt heater could be rewound.

Fig. 4 shows the results of tests made on the sterilizer with the two different elements. The verticle line near the top of the curve shows the point at which the power was turned off. Casual observation will show the much shorter time necessary to keep the 5000-watt heater connected than for the 3000-watt heater. The time for cooling before opening the sterilizer was noted and shows in the curves where they drop off at the end. The time for cooling in both cases was practically the same. The temperature at the top of the sterilizer when the smaller heating element was used was practically the same as at the bottom. This can be seen from the fact that it began to drop off immediately after the power was turned off. In the case of the 5000-watt heater the temperature at the top of the tank continued to rise for approximately two minutes and then dropped off abruptly for the next two or three minutes. The total power consumption in the case of the 5000-watt heater was only about 87½ per cent of that of the 3000-watt element. In other words, had these two elements taken their full rated power the 3000-watt element would have consumed 3.25 kw-hr. in order to bring the contents of the sterilizer up to the sterilizing heat, while the 5000-watt element would have consumed 2.84 kw-hr. It would be necessary, however, on such an intermittent service as the dairy sterilizing equipment requires to charge a higher demand rate on the 5000-watt element than on the 3000, making the cost in either case practically the same as that of the other. The big saving, therefore, comes in the amount of time necessary to do the work, it being necessary to have the larger element on only a little over half the time of the smaller element.

It is altogether possible that water could be heated in the sterilizer for the washing, as well as for sterilizing, thus eliminating the hot water tank, inasmuch as this particular hot water tank is in service only about one-half the time. The inconvenience suffered in this case is in getting the hot water from the sterilizer to the washer.

This sterilizer is of the type which has the hinged top uninsulated. In other words, one thickness of sheet metal is used for the upper half. No records were made on heat loss through this top. The contents of the sterilizer were weighed in the case of both the 3000 and 5000-watt elements, care being taken to see that the outfit was filled with practically the same quantity of material and the same kind in both cases. The curve showing the heating for the 5000-watt element was taken from one test, as is also the curve for the 3000-watt element, but another test was run on a different occasion on the 3000-watt element, showing a curve which falls very closely on that given on the chart.

TABLE II

Material	With 5000-watt element, pounds	With 3000-watt element, pounds
Milker	23.5	23.50
Milk cans	28.5	26.25
Miscellaneous	13.5	26.50
Strainer cloths	0.5 (wet)	
	Number	Number
Quart bottles*	26	24
Pint bottles*	27	26
Half-pint bottles*	12	12

*The bottles were taken from the crates and packed into the sterilizer so that practically all available space was filled.

Table II gives lists of equipment placed in the sterilizer for these tests:

A thermostat supposed to operate at 180 deg. F. was used in the circuit of the water tank heater. However, it was soon discovered that it was unnecessary to heat the water to such a high temperature for washing, as it had to be tempered with cold water so that the hands could be put into it. With this in mind, the current was turned onto the tank only part time. In this way the water was held at a temperature ranging from 120 to 130 deg. F. It was necessary to heat only about 2 gal. to boiling temperature for sterilizing.

A water meter was installed to record the amount of hot water used. The meter showed a total of 3870 gal. used in 105 consecutive days, starting with June 14. The power was turned off the tank about a week without our knowledge during a recent test, making our average since September 27 somewhat doubtful, but as nearly as can be determined the total for the 64 consecutive days following that date is 2900 gal. This makes the average daily use of hot water in this dairy, which is of average size (22 cows), 36.85 gal. for the 105 days and 45.4 for the 64 days. While the last average may not be absolutely accurate, it is near enough to indicate a requirement for more hot water during the colder months.

The power necessary to operate the water heater and sterilizer averaged 14.4 kw-hr. per day for six months, starting May 19 and ending November 18. This average does not include the power consumption for the first two weeks, when the dairyman was adjusting himself to its use. The daily consumption during the time this element was used averaged about 21 kw-hr.

The rate charged in Pullman for this power was 5 cents for the first 40 hr. of demand, 3 cents for next 60 hr., 1 cent for the next 100 hr., and ¾ cent per kw-hr. for all over.

The maximum demand on our 5000-watt element has been set at 4.6 kw-hr. Basing our figures on the average power consumption, as found from six months' records, the average monthly (30-day) power consumption would be 432 kw-hr. At the rate given above the average monthly cost of

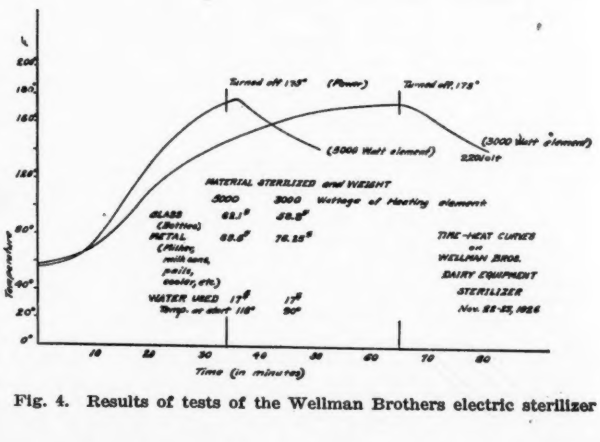


Fig. 4. Results of tests of the Wellman Brothers electric sterilizer

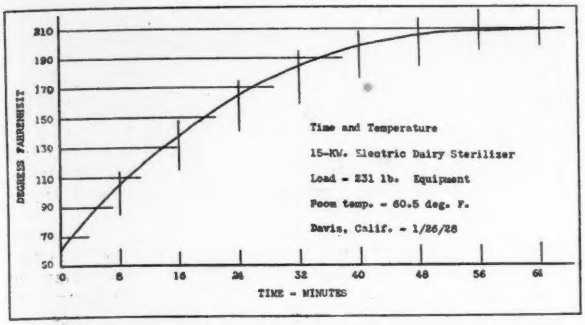


Fig. 5. Time and temperature curve of the 15-kw. sterilizer

heating water and sterilizing would be $16.64 (this includes the 1000-watt water heater). The sterilizer was used on an average about three times per day. The operator states that 30 min. was the average time for each filling. With this as a basis for estimating the power consumed by each piece of apparatus, we find the sterilizer consuming 6.9 kw-hr. Deducting this from 14.4 kw-hr. leaves 7.5 kw-hr. used by the hot water tank per day. This indicates that the 1000-watt heater ran on an average 7.5 hr. per day.

The hot water tank was carefully insulated with Arthur and Fowler "Fibreform" cover which has a heat insulating value of 80 per cent. This allowed the power to be on the tank at night and off during the day.

That the electric sterilizer has been a success on this dairy is readily seen by noting the record of bacterial counts as made by the state dairy inspector in Pullman, as follows:

	Bacterial count
January	2500
February	3000
March	2100
April	2200
May	2400
June	1700
July	2000
August	1700
September	2400
October	2600

The sterilizer was installed on this dairy and started operation May 5. Previous to its installation the dairy utensils were sterilized in boiling water over a small stove at a cost of approximately $6 per month.

The two greatest complaints dairymen have against this type of sterilizer are (1) it costs too much to operate them, and (2) they do not hold enough equipment. If all equipment could be sterilized at one time the cost of power might be considerably reduced, as the present electric sterilizing apparatus must be opened to remove the first batch and replace it with the second. During this time the outfit which contains only a small amount of water necessarily cools down to practically starting temperature.

To aid in the work of washing a bottle washer brush run by a ¼-hp. 1800 r.p.m. motor was installed. The motor was mounted on a bracket outside of the milkhouse. A single bearing was made by pouring babbit into an inch pipe around the bottle washer shaft. This bearing was made enough longer than the thickness of the wall to allow lock units to be turned on both ends. A flexible coupling made of a rubber hose on one end attaches the shaft to the motor and a pipe coupling on the other holds the brush, making the outfit complete. No record was kept of power consumption on this outfit as it works on the residence lighting circuit. This has proved very satisfactory.

A recording wattmeter was connected into the milkhouse circuit on this farm for a 24-hr. period and showed graphically what happened throughout that time, the sterilizer, the hot water tank, and the milking machine being the only dairy equipment metered. Electricity for lights for the dairy barn and milkhouse and power to operate the bottle washer are metered on the house circuit and is not separated from it. The sterilizer heating element, the element for the hot water tank, and the milking machine motor are all operated on a 220-volt circuit. All the other circuits about the farm and farm house are 110 volts.

In the California test conducted by A. W. Farrall[3], a large 15-kw. steam type electric dairy sterilizer located at the dairy barn and used in connection with the University of California dairy herd was tested and data obtained as follows:

The sterilizer consisted of a closed uninsulated galvanized box 4x4x5 ft., fitted with three 5 kw. General Electric immersion type, heating elements located in pipes below the trough in the bottom of the sterilizer tank. The sump held approximately 5 gal. of water and the water level was controlled by a float valve.

Utensils sterilized consisting of pails, milking machine parts and similar equipment amounting to 261 lb. were sterilized in one batch and records made of temperature, time and electrical consumption.

Fig. 5 shows the time and temperature characteristics. Steam vapor was obtained in 45 sec. after turning on the power; 26 min. and 40 sec. were required to obtain a temperature of 170 deg. F. and 68 min. were required to reach 209.5 deg. F. The weather was rather cool, (room temperature 60 deg. F.) resulting in considerable heat loss at the higher temperature and causing a slow increase in temperature near the end of the experiment. It is of note, however, that if the current had been kept on only long enough to hold the temperature above 170 deg. F. for 20 min., which is 5 min. longer than required by state law, the total time would have been only 46 min. and 40 sec. for the entire process.

The energy consumed was 17.4 kw-hr. which at 1.5 cents per kw-hr. would make the cost of the run as made 29.6 cents. The cost for 1 hour would be 26.1 cents. The cost per month at this rate would be (60x26.1) $15.66. Readings taken during the month of December showed the actual power bill to be $17.55 at the above rate.

A 5-kw. electric water heater was installed in connection with the above sterilizer and the total cost of current for the apparatus was $29 for December, at the same rate as that used by the sterilizer. The electric water heater was not very satisfactory on account of its small storage capacity; this was largely due to the fact that the water requirements of the dairy were materially increased after the installation had been made.

One of the difficulties encountered with the electric sterilizer was that someone accidentally turned off the water line to the sterilizer and allowed it to operate dry, thus burning out the heating elements.

Another difficulty observed was that equipment was left very wet after sterilization, resulting in rust. It seems that some method of drying the equipment and sterilizer after use would be of great assistance. Equipment should be removed from the sterilizer while yet hot if it cannot be dried in the sterilizer.

Publications. Publications issued during the past year, in connection with the dairy sterilizer were as follows:

1. Operating Characteristics of Oil Heated Steam Type Sterilizers, by A. W. Farrall, AGRICULTURAL ENGINEERING, September, 1927, vol. 8, No. 9, pages 237-240.
2. Operating Characteristics of Electrically Heated Hot Air Type Sterilizer, by A. W. Farrall, AGRICULTURAL ENGINEERING, December, 1927, vol. 8, No. 12, pages 341-343.
3. Operating Characteristics of Electrically Heated Steam Type Sterilizer, by A. W. Farrall and B. D. Moses, AGRICULTURAL ENGINEERING, October, 1927, vol. 8, No. 10, pages 273-277.

The committee is unanimous in the idea that its work should be continued during the coming year, as there are many problems remaining to be solved. It is recommended, therefore, that the program as outlined for the past year be continued for at least one more year, special emphasis to be placed upon the development of the hot air type sterilizer which seems to offer many advantages over the steam type. It is also recommended that study be made of low wattage, continuous water heaters for use in conjunction with the sterilizer.

Respectfully submitted,
COMMITTEE ON DAIRY EQUIPMENT STERILIZERS
A. W. Farrall, Chairman

H. L. Garver — W. C. Krueger
Geo. W. Kable — C. S. Mudge*

[3]Junior agricultural engineer, University of California. Mem. A.S.A.E.

*Advisory member.

The Way of Agriculture—Engineered

By L. J. Fletcher[1]

The new agricultural engineering building of the University of California, at the University Farm, at Davis, was dedicated November 12. A feature of the occasion was the dedication address of Mr. Fletcher, which follows. He was formerly head of the division of agricultural engineering at this institution, and it was largely through his personal efforts while in that position that the agricultural engineering building was secured. After the necessary funds had been procured, he planned the structure, but did not stay to see it built.—Editor

WHAT is agricultural engineering? Engineering may be defined as directing the utilization of the forces and materials of nature for the benefit of mankind. Agricultural engineering is, therefore, the directing of these same forces and materials for the benefit of agriculture. An engineering technique has long since been developed for such industries as mining, transportation, communication, and construction. Agriculture, the greatest of the world's industries, was the last to receive the attention of the engineer. Some of the reasons are obvious: The small size of the individual producing unit, the interlocking of a mode of living with the business of farming, the difficulty of extending to agriculture the work of the specialists.

Agricultural engineering is the youngest of the major divisions of the agricultural colleges and experiment stations in the United States. Thirteen years ago the division of agricultural engineering was established in this college of agriculture. J. Brownlee Davidson was the first professor of agricultural engineering in the University of California. For four years this new division grew under the diligent and efficient guidance of this recognized leader of his profession. This complete building and its effective program of activities is erected on the sound foundation laid by him. His vision of an engineered agriculture, an agriculture efficient in production and happy with its improved living conditions, was instilled in his students, his associates, all those who knew him. His work will carry on in California.

What is the way of agriculture? Let us look at three pictures; perhaps they will illustrate the way.

First, Mt. Vernon, the home of George Washington. Here we find a true picture of the organization of agriculture one hundred and fifty years ago. A fine home, though lighted with candles and heated with fireplaces, surrounded by a score of small buildings which housed such activities as cooking, spinning and weaving, soap and candle making, blacksmithing, carpentry, butchery, shoemaking—the work carried on largely by servants skilled in these various vocations. Here was a complete community making use of a hundred workers, producing all of the things necessary for their existence, with the exception of such materials as salt, iron and gunpowder. Over ninety-five per cent of the population of this country at that time were engaged in this kind of agriculture.

The second picture, Old Salem on the banks of the Sangamon River in Illinois, where Abraham Lincoln in 1833 was a partner in a store and later postmaster. The state of Illinois has made a park of this historic and interesting spot. Here as the visitor walks along the single street of the one-time New Salem, now Old Salem, he sees restored the evidence of the beginning of industry. A dozen small cabins line of street: Here labored the cobbler, next the wheelwright, there the cooper in whose shop Lincoln read at night in front of the large stone fireplace; over there a cabin in which the spinning of wool and weaving of cloth furnished the means for a livelihood. The hatter and the blacksmith were established in their embryo factories, and by the river was the miller. And yet the enterprise which at that time employed the most in labor, in capital, and produced most in wealth, was the farm. This was 90 years ago, when the average man by working hard all day, every day, could care for the crops on 12 acres of land. He was beginning, however, to exchange his product for the product of the worker in the village.

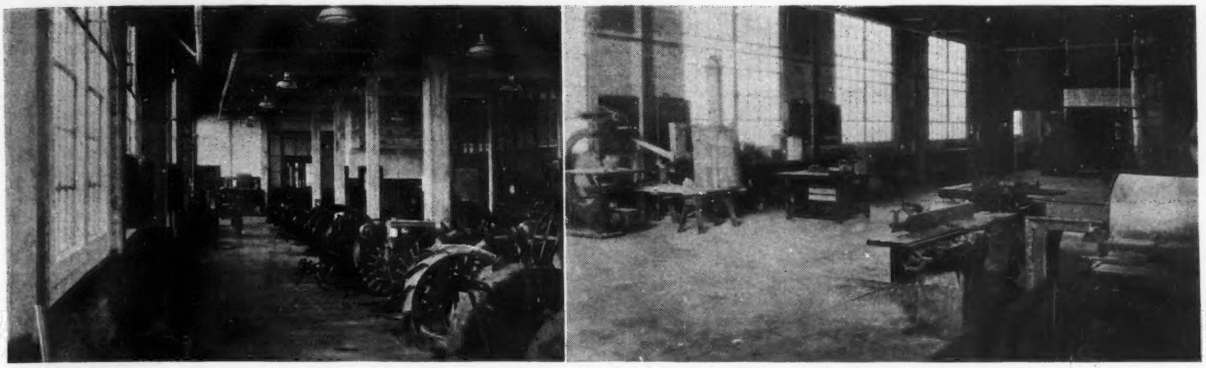
The third picture is today. Leaving Old Salem and driving over a concrete road in a "carriage" travelling 40 miles per hour (the speed limit in Illinois), an hour's trip will tell the story. Here is a farm implement factory employing thousands of men, a brick plant, a shoe factory, another establishment which turns out nothing but socks, but many of them; here a small town with a large group of busy buildings into which thousands of carloads of corn enter to come out as starch, sirup, corn oil, and corn sugar; a pile of baled straw 50 feet high and covering a block—raw material for the paper boxes used by a large manufacturer of breakfast food. The farms have changed also—machinery, electric service, better homes (some better than others for the ability and desires of men will vary).

Farming has not stood still in the race with the mushroom growth of industry. The productive efficiency of the farm worker increased fifteen per cent in the five-year period, 1917-21—a remarkable record in itself and a real tribute to the ability of the farmer of today, to the new machines of production made available to him, and to the efficiency of the agricultural college.

A popular diversion today is the comparing of agriculture with what is termed "industry," usually to the disparagement of agriculture. This is largely owing to the fact that the statistics quoted for agriculture are most often the average, that is, average cost, average yield, etc., while industry is

[1]Agricultural engineer, Caterpillar Tractor Company. Mem. A.S.A.E.

The new agricultural engineering building recently dedicated at the University of California, at University Farm, Davis. In closing his dedication address, Mr. Fletcher said: "So may this new agricultural engineering building, beautiful in its design for service, prove a fitting workshop for men destined to contribute much toward the solution of the complex problems of the agriculture of this state, of the nation, and of the world"



Interior views of two of the laboratories in the new agricultural engineering building at the University of California. (Left) The tractor and gas engine laboratory. (Right) A part of the agricultural engineering research laboratory.

largely known by the records of its most successful examples. The runner who endeavors to excel the average speed of his classmates will never make the track team. To win he must excel the best.

The average yield of cotton in Texas is 135 pounds per acre, the average cost of production 21.4 cents per pound. Yet 27 farmers in Texas raised an average of 1241 pounds per acre at a cost of 4.7 cents per pound. Examples of a similar nature exist for all crops and all sections of the country. Efficient farming today demands and is receiving the same intelligent management as is efficient industry. The very men who are making low-cost records in producing cotton, sugar cane, peanuts, corn, wheat, or fruit, are in every way capable of operating our prosperous industries; in fact, the chances are that if these managers exchanged places, some of agriculture's advisers might learn what it is to battle with such unruly variables as rainfall, temperature, winds, hail, bugs, and the consequent effects on surplus and price.

Some blame the engineer for the present agricultural problem of the surplus, saying we are suffering because the farmer's ability to produce is increasing faster than the nation's ability to consume. "Scientific agriculture is the salvation of the individual and the ruin of the mass" is a statement made in a recent book on the agricultural situation. However, the reader may pick up another treatise and read that " a surplus is a necessity and constitutes the difference between barbarism and civilization." Statistics are marshalled into books by authors who gravely warn us that in the not distant future the people of this country will be starving because of our inability to produce enough food; while others from the same statistics and with equal gravity aver that our farmers could produce over three times our present quantity of farm products without an increase in acreage, thus completely ruining themselves.

But this is America, where to hurt an economically sound industry is to benefit it. According to Merle Thorpe in "The Nation's Business," 2000 ice producers faced the entry of electrical refrigeration. Did they quit? No. They studied their own industry; they cleaned house; they stopped peddling ice and began to merchandize it; they increased their business seven per cent in 1927, with a still larger increase this year. Silk has not succumbed to rayon, or phonographs to radios. Montana, one of the first states to feel the crash of a hurt agriculture, is now one of the consistent white spots on the business map; it is demonstrating to the world profitable methods of growing wheat.

Many agricultural writers are alarmed at our decreasing consumption of food per capita; they point out that "all departments of human expenditures are capable of indefinite extensibility except the department of food." But remember that agriculture furnishes the material not only for food but for clothing and shelter as well. As we increase the buying power of this nation—the greatest free-trading area on the face of the earth, spending each year an amount equal to three times the value of the exports of all the countries of the world—we increase our ability to buy more shelter and more clothing. Science is opening the way toward a vast utilization of agricultural products for non-stomach uses. In 1921 nine million pounds of rayon were manufactured from cellulose, a material found in every plant that grows. This year 95 million pounds of rayon will be made from cellulose secured largely from cotton linters, wood pulp, peanut shells and corn stalks. O. R. Sweeney, of Iowa State College, states "Over 300 compounds have already been produced in our laboratory from agricultural wastes and every one of these materials has commercial possibilities." These products range from wallboard and paper to solvents and cloth.

Machine methods of production have not ruined our agriculture. We should rather credit farm machinery with reducing the expenditure of manual labor on our farms, with shortening the working day, with increasing the production per worker. Progress consists of continuously solving the problems of today which arise out of the solution of the problems of yesterday. To solve a problem is to create another.

Large-scale farming is in the air. The question is not whether we want the large farm but rather, what are we going to do with it? How will we direct its development?

This is an age of specialization. Other industries employing the specialist have prospered. As now commonly organized agriculture cannot most effectively employ highly trained men. The average farm unit is too small to bear the cost. However, the large farm is unusually attractive to the trained man. Because of valuable experience gained during recent years, more large farms are succeeding. The tendency of all successful industry is to expand—to increase the size of the project.

With the increase in the size and variety of labor-saving farm machines the short annual period of use of these machines on the smaller farm becomes an increasingly serious problem. For example, the load factor, that is, the percentage of annual full-load use of all power units employed, is about 4½ per cent on farms in the United States. Manufacturing industries enjoy a load factor of over 14 per cent. Were it possible to secure this load factor in agriculture, the present fifty million primary horsepower employed on farms could be reduced to less than twenty million. Some well-managed electric utilities are now securing load factors of over 50 to 60 per cent. Agriculture can hardly hope for such high utilization, but considerable improvement is feasible.

The most recent mechanical deevlopment in agriculture is the perfecting of field and belt machinery for use with the tractor. The mechanism for large-scale farming is available.

One of the present problems of agriculture is that of paying too much for credit. In general, money at comparatively low interest rates is available in this country for safe investments. If the present high credit charges are justified, how can the risk be removed so that agriculture may enjoy low money rates comparable with other industries?

The immigration policy, which keeps out of the country large numbers of people who would be content to use hand equipment in agricultural production, is making necessary the use of machines for multiplying the effort of the farm worker.

Our government has evidenced a real desire to aid agricul-

ture; the large, well-organized farming project should be able to realize the benefits of these relief measures.

To offset this picture of an industrialized agriculture, we have the desire of many to combine the privileges of rural life with an occupation. The farmer is largely independent in his everyday affairs. He is assured of a home and food, and is largely protected from the anxieties of the industrially employed. However, no matter how enjoyable are the possibilities of rural life, there is required a certain profit or income from which may be provided those things which are now considered necessities, particularly in the modern home. There are those who maintain that many of our agricultural workers would be far happier and able to live under much better conditions if they were working for others rather than attempting to run their own businesses. However, defining the requirements for the happiness of others is a rather dangerous undertaking.

California leads the nation in the engineering of her agriculture. She leads in the amount of power used per acre of improved land, and in income per farm worker. The amount of electricity used on the farms and in the farm homes is far in excess of that used in any other state——over 800 million kilowatt-hours per year. This is sufficient electric energy to operate two 50-watt electric lamps for four hours every night in the year in every farm home in the United States. Sixty thousand California farm homes are lighted by electricity; forty-eight thousand electric irons are employed; electric washing machines lighten the labor in twenty-eight thousand homes; while twenty-five thousand clean the floors with vacuum cleaners.

California has contributed much in the development of farm machinery. The combined harvester, which has revolutionized the grain farming industry in the great Middle West was conceived, built and operated in this state forty years ago. California originated the track-type tractor and many of the more efficient machines used in irrigation, in tillage and in the processing of fruit.

You have in California an agricultural engineering division as part of your college of agriculture, which is clearly second to none in any other state. The results of the research work carried on in this division have materially influenced such matters as the protection of farm machinery from dust and other causes of wear. It would be difficult to estimate the dollars-and-cents saving to farmers of this state, as well as of the nation, from this one outstanding example of well-conducted investigation. Other projects have included the more efficient utilization of electricity on California farms, the improvement of dairy equipment, better design and utilization of many types of harvesting machinery, and the improvement of farm structures, particularly those employed in the poultry and dairy industries. The encouragement of the use of a simple type of septic tank has resulted in improved sanitary conditions in our rural communities.

Thousands of California people have received instruction in the proper selection, use and care of all types of farm equipment in the regular courses here at the University Farm, as well as in many extension courses and meetings conducted by the agricultural engineers of the University. Citizens of other states and other nations are privileged to learn here "the way of agriculture—engineered," the way toward profitable production and comfortable homes.

So may this new agricultural engineering building, beautiful in its design for service, prove a fitting workshop for men destined to contribute much toward the solution of the complex problems of the agriculture of this state, of the nation, and of the world.

Increasing the Efficiency of Tractor Operation

By Clyde C. Gillies[1]

THE arrangement of the tractor shown in the accompanying illustrations is not the result of our (Canadian) liberal liquor laws, but merely an effort to overcome some of the disagreeable features encountered in tractor operation.

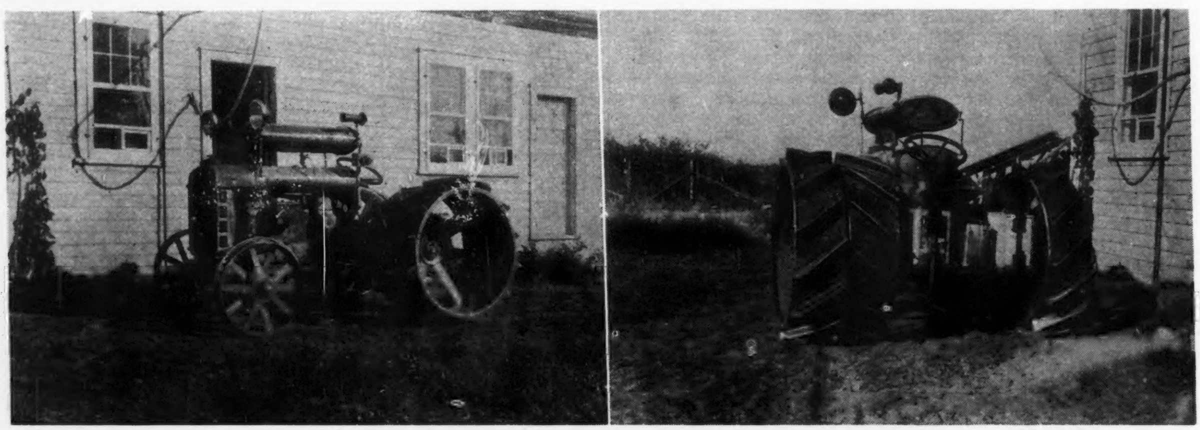
The threshing season of 1927 was far from ideal from a weather standpoint, so the tractor was equipped as shown. I found the proper way to start the day wrong was to get out in the chill, gray dawn, fill the tractor with icy cold water (a considerable quantity always went on me) and then crank until the conditions were right for starting. After a few days of this sort of thing, I brought the tractor home at night and put it in a heated garage.

Hauling a tank wagon from field to field also proved a nuisance, so the tractor was supplied with the additional fuel tank shown in the illustration, and a platform on the rear axle housing which carries cans holding eight gallons of water and one gallon of cylinder oil. With this arrangement the tractor leaves the garage in the morning supplied with fuel, oil, and water sufficient for the longest day's run.

The short days of late October made it necessary to shut down at 6:30 p.m. on account of failing light. However, the addition of headlights gave light on the feeder and enabled threshing to continue until 7:00 p.m. The headlights also made it possible to move the outfit at night, a feature which every operator of a threshing outfit will appreciate.

After two years of operation I can heartily recommend this arrangement to any operator of the same make of tractor. He will find the few dollars spent in this equipment will soon be returned to him.

[1]Owner and operator, Chattan Hill Farm, Strathcona, Alberta, Canada. Assoc. Mem. A.S.A.E.



These pictures show how Clyde Gillies, an Alberta (Canada) farmer, equipped his tractor to carry a full-day's supply of fuel, oil, and water, and also the headlight equipment provided for operation at night

A Study of Heat Loss From Flat-Irons

By A. G. Tyler[1]

THE ability of flat-irons to hold heat under different conditions of use, the amount of heat lost in various ways, and other considerations were made the subject of a study by the agricultural engineering division of the University of Minnesota. It is the purpose of this paper to describe the tests and present the results.

The amount of heat in a flat-iron or other object depends upon its temperature, weight and specific heat. For instance, a six-pound flat-iron at a given temperature contains more heat than a four-pound iron at the same temperature. Again a six-pound iron at 300 deg. F. contains more heat than a six-pound iron at 200 deg. F. The specific heat item is of little importance in this case as nearly all flat-irons are made of cast iron. Some irons are nickle-plated and most of them have wooden handles. In this investigation the entire weight is assumed to be cast iron, as under this condition the specific heat item may be neglected.

Since the weight and specific heat of any flat-iron are constant, the only variable is that of temperature. The person using the iron is not so much interested in the amount of heat contained in the iron as in its temperature. It is possible then to express the value of any flat-iron in terms of temperature or rather in the fall in temperature of a certain weight iron in a certain time. Inasmuch as the room temperature was not constant, this factor has also been used in calculating the results.

For this test there were available five irons of different makes, weights, shapes and surface conditions; they were an American Beauty electric, a Blau-gas, an acetylene, a Dover covered iron and a Geneva solid-handled iron. The first three were regular laboratory equipment, while the other two were secured from private homes. A description of these irons is given in Table I.

The irons were heated with electricity (32-volt), acetylene or Blau-gas according to type. The Geneva and Dover irons were heated over open gas flames. The tests were made in a basement room which had a fairly constant temperature. In general the air was quiet but a 12-in. electric fan was available for producing such air motion as was wanted. The room temperature under test conditions varied from 74 to 85 deg. Fahrenheit.

Conditions and personal opinion influence the temperatures to which flat-irons are heated. In general, for work on heavy materials, especially if they are fairly damp, a good hot iron is desirable, while for lighter or finer work a lower temperature is better. The universal method of testing the temperature of a flat-iron is to touch a moistened finger to the bottom of the iron; if it hisses it is at least hot enough. The upper limit of temperature is not so easily determined.

The process known as ironing consists of changing the moisture in the cloth, or other material, to steam and at the same time applying a more or less heavy pressure. The steam makes the fibers pliable and the pressure causes them to lie flat or take the desired shape. It follows, therefore, that a flat-iron must have a temperature above the boiling point of water (212 deg. F. at sea level) in order to be effective. Weight or downward pressure is also necessary, for the softened fibers must be held in place until dry or nearly so if they are to remain that way for any length of time.

Flat-irons used in private homes are limited to about six pounds in weight, although there are many smaller and lighter irons used for special purposes. There should be and generally is a more or less definite relation between the weight of the iron and the area of the base or ironing surface. For most household irons this ratio is about one-third of a pound per square inch of base area. In all probability this ratio has been established by actual experience. If the weight is less per square inch, too much additional pressure must be applied by hand; if the weight per square inch is more than usual, less surface can be covered per unit of time.

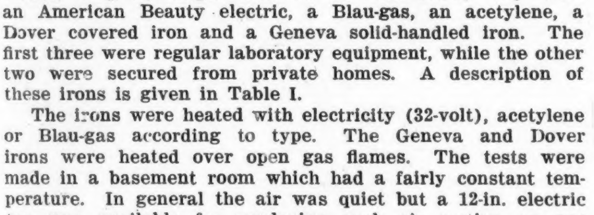
The particular object of this investigation was to find out which iron lost its heat the quickest and under what conditions. It did not seem advisable to actually measure the heat input and output, as this would have to be done under conditions which would not be comparable with usual ironing practice. Some difficulty was experienced in finding a method of getting the actual temperature of the iron. It is evident that in actual use the bottom of the iron loses heat faster than any other portion, and inasmuch as that is the business part of the iron, it was decided to take the temperatures there.

A 95 per cent magnesia brick 10x8x2 in. was bedded in fine sand in a wooden box. Magnesia was chosen because it was the best available non-conductor of heat that would not burn or char at the temperatures which would be used. A shallow groove was cut in the upper surface of the brick to take an ordinary mercury thermometer. The particular thermometer used was graduated from 0 to 650 deg. F. The thermometer was bedded in this groove in such a manner that the bulb actually came in contact with the bottom of the iron, the center of the bulb being 2¼ in. from the point of the iron. In all probability the thermometer did not actually register the temperature of the face or bottom of the iron, but at least conditions were the same for all of the irons. Some trouble was experienced due to the softness of the magnesia brick, the thermometer having a tendency to sink into the material until it was no longer in contact with the face of the iron. The groove was finally enlarged somewhat and filled with plaster of paris; the

TABLE I. Description of Flat-Irons Tested

	Weight, lb.	Surface	Area of base, sq. in.	Sq. in. of base	Handle	Remarks
Electric	6.163	Nickle	19.536	.315	wood	Good condition
Acetylene	7.715	Nickle	20.158	.357	wood	Good condition
Blau-gas	5.739	Nickle	20.480	.280	wood	Good condition
Dover	4.823	Nickle, rusty	16.176	.298	wood	Poor condition, double ended: bottom slightly rounding
Geneva	4.953	Plain, very rusty	14.768	.335	iron	Poor condition

[1]Assistant professor of agricultural engineering, University of Minnesota. Mem. A.S.A.E.



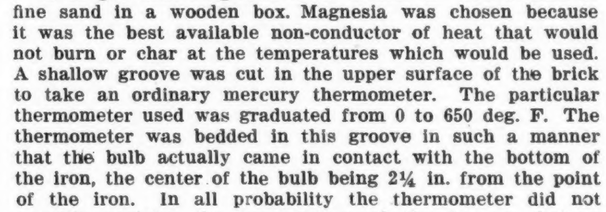


Fig. 1. (Left) Irons tested. From left to right are the acetylene, Dover, electric (on magnesia brick), Geneva and Blau-gas.
Fig. 2 (Right) Some of the stands tested. From left to right they are sheet metal; cast iron; wood, asbestos, and round headed thumb tacks; bright tin with four bosses; and stove lid

thermometer was placed in this material and pressed down with a flat-iron. As soon as the plaster of paris had set, the whole surface was scraped and rubbed down until the thermometer bulb was actually in contact with the iron. The small amount of plaster of paris had no appreciable effect on any of the tests.

After a number of trials of various sorts the method adopted was as follows: The iron, if of the self-heating type, was placed on a well-defined spot on the brick and the heat applied. When the thermometer indicated a temperature of about 300 deg. F., the gas or electricity was turned off. The temperature of the iron as indicated by the thermometer invariably continued to rise for a short time after the heat was turned off. In general the iron was heated to a temperature somewhat higher than the one desired and then allowed to cool back to the selected point. After asking various people what they considered the proper ironing temperature and getting few replies of any value, the temperature of 310 deg. F. was chosen as being about right.

When the iron had cooled back to this temperature or near it, it was shifted to the particular stand or position to be tested. The iron was left on the stand 10 min. then moved back to the magnesia brick and left there 5 min. The temperature indicated by the thermometer at the end of this 5 min. period was assumed to be the temperature of the iron.

For reasons before given it seemed best to figure drop in temperature rather than actual heat units lost. From the weight of the iron, temperature of the iron and room temperature and time interval it was possible to calculate temperature drop per minute, the temperature drop per minute per pound of iron, and the temperature drop per minute per pound of iron per degree difference in iron and room temperatures. This last figure seems to express the value of the iron and stand as heat retainers.

An analysis of the figures given in Table II shows that the temperature drop of the electric iron was the lowest with the Blau-gas, acetylene, Geneva and Dover following in their order. Naturally the temperature drop per minute held the same order. When the tmperature drop per minute per pound of iron is considered the order changes to acetylene, electric, Blau gas, Geneva and Dover. When the other factor, temperature difference between iron and room, is considered, the order again changes to electric, acetylene, Blau-gas, Geneva and Dover.

A consideration of the type of stand indicates that there is not much choice in the shape, size or material of which the stand is made. All of the metals are good conductors, and if a hot flat-iron is placed on a smooth iron stand (such as a stove lid for instance) the flat-iron loses heat very rapidly by conduction. Asbestos paper, bright tin, plate glass or any other material commonly used for stands is but little better than the cast iron. If, however, the flat-iron is kept from coming in contact with the stand except in three of four points the heat loss is greatly reduced. A stand made of a piece of pine board, a sheet of asbetos paper, and three round headed thumb tacks is as good or better, so far as heat loss is concerned, than any of the elaborate stands that are commonly used. The best stand, so far as the writer knows, is the one shown at the left in Fig. 2. This stand is light, substantial, nickle plated and has a double row of bosses to keep the iron from close contact with the stand. The chief objection to a stand of this kind is that the iron must be lifted about 2 in. each time it is put on the stand.

Ironing is, at best, a warm job. The aim of most every woman is to place her ironing board in front of an open door or window or better still on an open porch where there is a good breeze. This practice is fine for the operator but hard on the iron.

Some of the self-heating irons such as those that burn gas, gasoline, and alcohol have an adjusting valve for controlling the size of the flame. With irons of this sort the type of stand is of little consequence but they must be kept out of strong drafts or the flame will be blown out. Most electric irons have heating elements large enough to allow continuous use on rather damp clothes without undue cooling.

Table II. Results of Tests of Heat Loss From Irons

Stand	Iron Temp.	Final Temp.	Temp. Drop	Time	Temp. Drop per Min.	Temp. Drop per Min. per Lb.	Room Temp.	Temp. Diff. Iron-Room	Temp. Drop per Min. per Lb. per Deg.
ELECTRIC IRON— Weight 6.165 lb.									
Sheet metal	308	244	64	15	4.26	0.692	79	229	.00302
Cast iron	308	233	75	15	5.00	0.812	78	228	.00354
Sidewise to breeze	308	214	94	15	6.27	1.019	80	228	.00447
Stove lid	308	196	112	15	7.48	1.212	80	228	.00532
On end	308	247	61	15	4.07	0.660	79	229	.00288
Five thicknesses asbestos paper	310	231	79	15	5.27	0.855	74	236	.00363
ACETYLENE - Weight 7.715 lb.									
Sheet metal	307	228	79	15	5.27	0.683	82	225	.00304
Cast iron	306	221	85	15	5.66	0.738	84	222	.00331
Sidewise to breeze	306	170	136	15	9.07	1.175	82	224	.00520
Stove lid	308	203	105	15	7.00	0.906	85	223	.00407
Five thicknesses asbestos paper	306	214	92	15	6.14	0.795	75	231	.00345
BLAU-GAS - Weight 7.74 lb.									
Sheet metal	308	220	88	15	5.86	1.022	83	225	.00454
Cast iron	306	215	81	15½	5.22	0.912	83	223	.00408
Sidewise to breeze	308	177	131	15	8.74	1.524	83	225	.00678
Stove lid	306	202	104	15	6.94	1.250	83	223	.00542
Five thicknesses asbestos paper	311	226	85	15	5.32	0.927	79	242	.00383
GENEVA - Weight 4.95 lb.									
Sheet metal	307	223	84	15	5.60	1.13	83	224	.00505
Cast iron	308	223	85	15	5.67	1.15	83	225	.00512
Sidewise to breeze	310	203	107	15	7.14	1.44	83	227	.00634
Stove lid	308	197	111	15	7.34	1.48	83	225	.00658
On end	310	228	82	15	5.48	1.15	78	232	.00494
DOVER (Covered Iron) 4.74 lb. with cover - 4.16 lb. without									
Sheet metal	306	235	71	15	4.73	1.00	81	225	.00444
Cast iron	304	227	77	15	5.13	1.08	81	223	.00484
Sidewise to breeze	304	219	85	15	5.67	1.19	83	221	.00542
Stove lid	304	215	89	15	5.93	1.25	81	223	.00563

Note: Temperatures given are degrees Fahrenheit.

A number of other stands tested, particularly with the electric iron, showed no significantly different results.

CONCLUSIONS

A good flat-iron, so far as its ability to hold heat is concerned, should be compact, that is, have as little surface as possible, be as heavy as is convenient to handle and have as smooth a surface as possible, nickle plate being very good. Any gas-heated iron has relatively more surface than any of the solid irons. The extra outside surface is of less importance than rough inside surface which is an extremely good radiator. Of the three ways in which heat may be lost from a flat-iron, convection is the most important, conduction a close second, and radiation a poor third.

The best kind of a stand depends on the iron. If it is an electric or one of the old square-back kind the best possible stand is the back of the iron. If the iron cannot be stood on end owing to gas hose or to the fact that it is of the double-pointed type, the best stand is of thin sheet metal having small raised bosses, or some other means of keeping a film of air between the stand and the base of the iron. The light, open, cast iron stand comes next while the solid iron stands (such in effect as a stove lid) are third, and placing the iron in front of an open window is worst of all.

To summarize briefly, avoid large bulky irons of comparatively small weight; keep the entire surface as smooth (polished) as possible; avoid drafts (on the iron); avoid heavy cast stands, and stand the iron on its own rear end if there are provisions for it.

EDITOR'S NOTE: The stands tested which are not indicated in Table II, include asbestos paper with bosses, plate glass polished sheet metal, smoked sheet metal and various combinations of asbestos, tin, and pine.

A Dynamometer to Test Man's Power Capacity

By E. G. McKibben[1] and J. S. Winters[2]

THE apparatus shown in the accompanying illustrations was built to give students in the farm power courses of the college of agriculture at the University of California a definite idea of the manual equivalent of the common power units, and a realistic conception of how hard a man must work in order to earn ten cents a day in competition with a gas engine or an electric motor. It has proved highly satisfactory, not only for the purpose for which it was built, but also as an instructive and entertaining piece of equipment which has attracted the favorable attention of all classes of visitors.

It attracted more attention than any other object in the Agricultural Engineering Building on Picnic Day, May 21, 1928, the annual open house of the College of Agriculture. Visitors were operating it practically all day. A chart made by a Service Recorder recorded the time during which the dynamometer was in operation. The chart showed almost continuous operation from 9:30 a.m. to 6:30 p.m. except a short period at noon and 6:00 p.m., and a period of about an hour and a half during the parade in the afternoon. Considering that at most it takes less than a minute for an individual to test his power capacity, it is evident that a large number of visitors gained a clearer conception of the meaning of the common power units.

An automatic Toledo scales was placed beside the dynamometer to enable the visitor to compare his weight as well as his power capacity with those of his friends. There was also a chart giving the cost per horsepower-hour for gas engines and electric motors. When a husky visitor or student learned that his maximum power capacity was about 1.5 hp. (for a run of a few seconds), and that working at that rate continuously he would earn only 6 to 15 cents per hour competing with mechanical power, he had a new respect for the gas engine and the electric motor.

Construction. The dynamometer itself is rather simple and is merely a new arrangement and application of several old ideas. It consists of a shaft, a, mounted in ball bearings on frame, b, and an adjustable crank, c; two old gas engine flywheels, d; a forge blower, e, mounted on shaft a in such a way that any rotation of shaft a tends to rotate the blower frame; a pendulum, f, to prevent the blower frame from rotating causing the blower fan to rotate instead; a dial, g, to indicate the torque; a speedometer, h, to indicate the speed; and a discharge throttle, j, to vary the torque required for operation at any given speed. The throw of the crank is adjustable from 9 to 14 in. The crank is also equipped with a ratchet to prevent danger of accident due to the kinetic energy stored in the flywheels. The flywheels are faced with sheet steel to reduce windage and prevent the possibility of accident due to a careless operator or spectator getting his hand or arm caught between the spokes and the frame.

Calibration. The original plans called for the reading of both torque and speed during each test, and for figuring the power from these readings. However, experience indicated that as a practical teaching and demonstration apparatus the best results would be obtained by running with open throttle and calibrating the speedometer directly in horsepower. This was possible because, except for changes in bearing friction and changes in air density, a given blower requires a definite power to drive it at any given speed and discharge opening. If the bearings are kept well lubricated there is little change in bearing friction. Also, the changes in pressure and temperature found in a properly heated laboratory do not affect the air density enough to interfere with the use of such a calibration for teaching and demonstration purposes, although they would have to be considered in a highly scientific study. The relationship between the r.p.m. of the crank and the power required for operation with open throttle is shown in the accompanying calibration curve.

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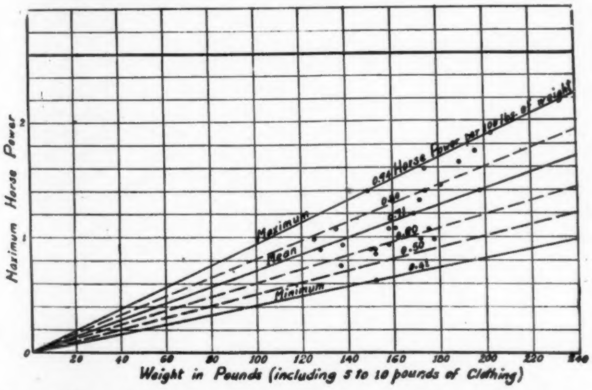
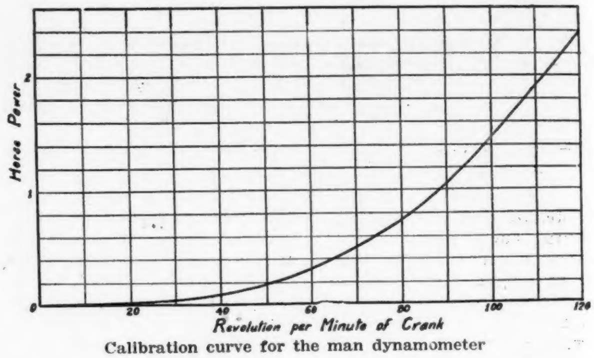


Curves showing results of a test of the maximum power of twenty-six college students

This dynamometer was built to test man's power capacity and show how hard he must work to earn ten cents a day in competition with mechanical power and consists of a shaft, a, mounted in ball bearings on frame, b, and an adjustable crank, c; two old gas engine flywheels, d; a forge blower, e, mounted on a shaft, a, in such a way that any rotation of the shaft, a, tends to rotate the blower frame; a pendulum, f, to prevent the blower frame from rotating causing the blower fan to rotate instead; a dial, g, to indicate the torque; a speedometer, h, to indicate the speed, and a discharge throttle, j, to vary the torque required for operation at any given speed

Note that the power required increases rapidly at the higher speeds; also, that the speed required for one-tenth horsepower (often given as the continuous power capacity of a man for a working day) is 50 r.p.m., which seems to be a comfortable speed, if this word can be applied to the process of turning a crank.

Results. The results obtained with a class of twenty-six college students ranging in weight from 125 to 203 lb., and in age from 19 to 24 years are shown graphically in the accompanying curves. Note that the mean horsepower per 100 lb. of weight was 0.71. Experience with many visitors seems to indicate that ¾ hp. per 100 lb. is about an average figure. Also, note that the maximum horsepower obtained was 1.95. This man was a star football tackle. So far this stands as a record for the manual operation of this machine.



Calibration curve for the man dynamometer

Removing Trees by Direct Pulling

By D. B. Lucas[1]

A LARGE mechanical advantage combined with sufficient anchorage makes possible the removal of almost any tree or stump. The outstanding disadvantage of most methods of stump pulling is the time required for moving and setting up the apparatus. For that reason it is always desirable to uproot trees and stumps by the direct force of the applied power when possible.

Despite the fact that trees, especially live trees, are usually very firmly rooted in the ground, there are many which may be pulled out directly by a tractor or team. The application of a little skill in the manipulation of the tractor, proper attachment of the cable or chain to the tree, and successive pulls in advantageous directions can put an end to a good sized tree.

The fruit farm of the New Jersey Agricultural Experiment Station furnished a good example of effective stump pulling this summer. An old orchard had been partially cleared off, leaving stumps ranging from 8 to 12 inches in diameter. The clearing equipment consisted of a heavy 20-foot log chain and a light tractor. The tractor operator was an expert at getting a maximum force on the drawbar but very few of the stumps would give way to a single, straight pull. However, by effective short jerks and frequent shifting of the direction of pull the majority of the stumps came out speedily. The chief advantage of the long chain is that it permits shifting the tractor from one position to another very easily, and without the necessity of unhooking either end.

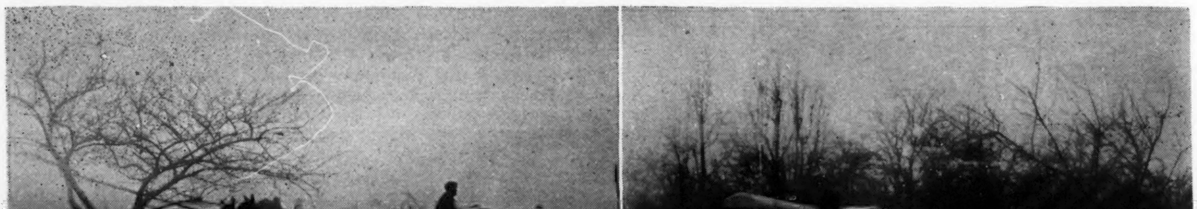
Some standing trees were removed at the same time. The trees offered greater leverages for pulling than did the stumps and came out without difficulty. The accompanying photographs show four stages in the downfall of a full-grown apple tree. The remarkable speed of this method of clearing land is its strongest recommendation.

[1]Assistant professor of agricultural engineering, Rutgers University. Assoc. Mem. A.S.A.E.

A Correction

There were some errors in the caption to the illustration which appeared on page 339 of the November, 1928, issue of AGRICULTURAL ENGINEERING. The caption should read as follows:

(Left) This picture shows the appearance of an untreated plot on the Vale (Oregon) alkali experimental tract after seven years cultivation and irrigation. All efforts to get a crop to grow on this plot have failed. (Right) Ten tons manure per acre has been applied during each of the past four years, and one and one-half tons per acre sulfur applied two years ago. The soil has been greatly improved and a good crop of sweet clover is being produced at the present time. This experiment shows there is virtue in the application of sulfur and manure though the cost is rather high for general use.



Four stages in the removal of a full-grown apple tree. Note that the chain is hooked through the tree to the limbs on the side opposite the direction of pull. The second and third pictures show how the method of hooking gives a continuous leverage

Agricultural Engineering Digest

A review of current literature on agricultural engineering by R. W. Trullinger, specialist in agricultural engineering, Office of Experiment Stations, U. S. Department of Agriculture. Requests for copies of publications abstracted should be addressed direct to the publisher.

House Drainage and Sanitation, F. J. Taylor (Estate Magazine, (Letchworth, Herts, England) 26 (1926), No. 11, pp. 829-839, figs. 10.)—Considerable information is given on the disposal of residential sewage under rural conditions in England, including drawings of fixtures.

The Theory of Structures, C. M. Spofford (New York and London: McGraw-Hill Book Co., 1928, 3. ed., rev. and enl., pp. XV + 587, figs. 414).—This, the third, revised edition of this book, contains chapters on outer and inner forces; laws of statics, reactions, shears and moments, and influence lines; concentrated load systems; beam design; plate girder design; simple trusses; bridge trusses with secondary web systems, including the Baltimore and Pettit trusses; trusses with multiple web systems, lateral and portal bracing, transverse bents, and viaduct towers; cantilever bridges; three-hinged arches; design of columns and tension members; pin and riveted truss joints; graphical statics; deflection slope and camber; statically indeterminate girders and trusses; space framework; swing bridges; masonry dams; earth pressure; masonry arches with fixed ends; and framed bents for high buildings.

Insulating Value of Building Materials, F. E. Fogle (Michigan Station (East Lansing, Mich.) Quarterly Bulletin, 10 (1928), No. 3, pp. 97-104, figs. 9).—Data on the insulating of various building materials are presented, with particular reference to their use in farm structures.

Poultry Houses and Fixtures, M. A. Jull and A. R. Lee (U. S. Department of Agriculture, Farmers' Bulletin 1554 (1928), pp. II + 30, figs. 29).—This is a revision of and supersedes Farmers' Bulletin No. 1413. It gives detailed information on how to build poultry houses.

Value of Building Insulation to Reduce Heat Losses, E. N. Sanbern (Journal American Society of Heating and Ventilating Engineers (New York, N. Y.) 34 (1928), No. 3, pp. 197-203, figs. 6).—Data are presented on different insulating practices, indicating the saving which may be attained. It is pointed out that the best way to install insulation from the standpoint of efficiency of heat transmission is to place it in the center of an air space so that it will divide the air space into two smaller dead air spaces.

Residential Water Heating, R. R. Herrmann and K. R. McClung (Electrical World, (New York, N. Y.) 91 (1928), No. 7, pp. 341-346, figs. 8).—The results of investigations on residential water heating are presented, the purpose being to reduce the cost of such service. No conclusions are drawn.

Free-Burning Carbonized Fuels for the Open Fire, H. H. Greger (Fuel, 7 (1928), No. 2, pp. 90, 91).—This is an abstract by W. T. R. Braunholtz of a report from Germany of experiments conducted in Japan with 14 different free burning fuels. In general, it was found that increasing ignition temperature corresponds to an increase in the volume of air per minute required for fuel consumption of 40 per cent for all fuels tested except gas coal semicoke.

The Greenhouse, G. Lampmann (Der Gewachshausbau. Berlin: Wilhelm Ernst & Son, 1927, pp. VI + 114, figs. 46).—Information is given on the planning and construction of greenhouses from the German point of view.

The Northwest Station Poultry House, A. M. Pilkey and A. M. Foker (Minnesota Station, Crookston Substation (Crookston, Minn.) Report 1926, pp. 59-63, figs. 4).—Specifications and a bill of material for this poultry house are given.

Construction and Arrangement of Hog Stalls [trans title], Speckmann and Dettinger (Veroffentl. Landw. Kammer Rheinprov., (Bonn, Germany) 13 (1928), pp. 9, pls. 11).—Practical information on the subject is given from the German viewpoint.

Buildings and Equipment for the Dairy Farm, F. D. Cornell, Jr. (West Virginia Station Circular 49 (1928), pp. 47, figs. 39).—Practical information is given on the planning and construction of buildings and equipment for dairy farms in West Virginia, together with working drawings.

Better Tobacco Barns, L. H. Lewis and R. E. Currin (Clemson Agricultural College, South Carolina (Clemson College, S. C.) Extension Circular 93 (1928), pp. 12, figs. 3).—Practical information on the planning and construction of tobacco barns is given, together with working drawings.

Electricity Helps Lift the Load from Bended Backs (Wisconsin Station Bulletin (Madison, Wis.) Bulletin 396 (1927), pp. 21-27, figs. 2).—A progress report is given of investigations on the use of electricity in agricultural operations (Agr. Engin., 8, p. 258), including feed grinding and silage cutting. Data on the cost of operating an individual electric light plant are also included, together with data on saving labor in haymaking and storing.

Electrical Truck Garden Culture [trans title], G. Lind (K. Landtbr. Akad. Handl. och Tidskr., (Stockholm) 67 (1928), No. 1, pp. 49-65, figs. 5; also in Meddel. K. Landtbr (Sweden) Akad. Exptlfalts. Trandgardsavdel., No. 25 (1928), pp. 17, figs. 5).—Apparatus for the artificial heating of truck garden soils by electricity is described, and experiments on the use of this means of heating to supplement sun heat for potatoes, cucumbers, and other truck crops are reported and discussed. The results indicate that earlier maturity may be secured by this practice, particularly with cucumbers and other crops which are likely to be infested with diseases at later maturity.

The Relation of Electricity to Missouri Agriculture, R. R. Parks and J. C. Wooley (Missouri Station (Columbia, Mo.) Circular 165 (1928), pp. 11).—A brief outline of the activities of the station in connection with the development of rural electrification is presented.

Chemical Character of Waters of Florida, W. D. Collins and C. S. Howard (U. S. Geological Survey, (Washington, D. C.) Water-Supply Paper 596-G (1928), pp. IV + 177-233, figs. 8).—The results of this study indicate that the surface waters of Florida differ widely in composition. In general, however, the rivers and smaller streams carry only small quantities of dissolved mineral matter. All the rivers become blackish toward their mouths. Nearly all the surface waters are noticeably colored, and the larger lakes and streams generally have more color than the smaller ones. Detailed data are also given on the quality of the ground waters in western, northern, central, and southern Florida.

Book Review

"Land Drainage and Reclamation," by Q. C. Ayres and D. Scoates, is published to fill a need for a treatise on ordinary farm drainage, reclamation and surveying problems which a farmer may expect to handle without the aid of a specialist in this field. The book is intended primarily as a text for college students in agriculture and also for farmers and as a reference book for practicing engineers. It is not a text on surveying or drainage engineering. The mathematics are eliminated or simplified as much as possible without destroying the effectiveness of the material. A feature not found in other elementary books on the subject is the chapter on "Useful Principles of Law" as applied to farm waters. The chapter headings are: Introduction, measuring distances, surveying with steel tape, levels and level rods, leveling, adjusting levels, lines and angles, topographical surveying, computing areas, land surveying, drainage properties of soils, rainfall and run-off, open-ditch design, open-ditch location and construction, open-ditch maintenance, earth dams and levees, drainage districts, useful principles of law, explosives and their use, clearing land of brush, clearing land of stumps, control of soil washing, sub-surface drainage, location of tile drains, design of tile drains, selection of tile, installation of tile, drain-tile accessories, estimating cost of tile drainage, and special methods of drainage. Practical tile-drainage problems are given in the appendix. It is believed that the book will find a wide application throughout the country. The McGraw-Hill Book Company, New York, N. Y., has made it available at the list price of $4.00.

"Synthetic Nitrogen," is the title of a profusely illustrated booklet picturing the fundamental principles—including mass production, large scale operation, intensive scientific research, elimination of waste, utilization of by-products, constant endeavor to adapt the products to the needs of the markets—employed in winning nitrogen from the air. It is published in Germany, but in the English language, and describes, in a brief, non-technical way the fixation of nitrogen by the "Haber-Bosch Ammonia Fixation Process" at plants in Oppau and Leuna, Germany. It treats in the same way the subsequent manufacture of fertilizer from the nitrogen, research on the application of fertilizers and also the working and living conditions provided for the 36,700 employees of the two plants. The booklet is made available in America by the agricultural department of the Synthetic Nitrogen Products Corporation, of New York, Atlanta, and San Francisco.

"The McCormick-Deering Gas Engine Handbook," is a brief, non-technical, illustrated treatise on the principles of operation of the internal-combustion engine and on the care and repair of the McCormick-Deering engine. Information on pulleys, belts and the calculation of speeds is also given. It is published by the International Harvester Company.

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RAYMOND OLNEY, Editor

Scientific Selection

"THE manufacturer of farm equipment has undoubtedly, through many trials, satisfied himself that a particular piece of machinery will work, but he should do more than this. He should, through sufficient trials, in cooperation with farmers and agricultural experiment stations, be able to give definite information to each prospective buyer as to what is the best size and type of machine to be used under any given set of conditions. The purchase of unadapted or unsuitable machinery is a loss to a farmer, which may prevent him from obtaining other needed equipment that will increase his profits."

The foregoing statement made by Roy Johnson, owner of Wandaroy Farm in North Dakota, before the recent annual convention of farm equipment manufacturers, is of particular interest and significance to agricultural engineers.

The farm equipment manufacturers have already made considerable progress in the direction recommended by Mr. Johnson. The opportunity, however, is unlimited, and Mr. Johnson's suggestion not only merits consideration, but a definite effort might well be put forth to carry it out more extensively, and on a more scientific basis. The results surely would work to the great advantage of farmer and manufacturer alike.

The efficiency and prosperity of the agricultural industries, as is true of other industries, is dependent in large measure on the proper selection of equipment, as to type, size, etc., to meet given conditions and requirements. What do we know about the duty ("duty" used in its engineering sense) of the great variety of types and sizes of farm implements and machines in use today? What does the manufacturer, or the farmer, or the agricultural engineer in state or federal employ or in private practice know about it? The answer is that so far as the selection of agricultural equipment being on a scientific basis, there is much to be desired.

In spite of this fact, however, it may be said that, between the manufacturer and the farmer, a pretty fair job of selecting the most suitable equipment is being accomplished now. But there is much room for improvement. Improvement in this respect would tend to lessen the farmer's chances of getting unsuitable equipment, and, from the manufacturer's point of view it would contribute to stablizing the farm equipment business.

The accomplishment of this desirable result can best be attained by cooperative effort. Closer cooperation between manufacturer and farmer is essential, but to carry out such a project on a comprehensive scale, involving as it would a considerable educational effort, the services of a third factor should be enlisted—the agricultural engineer in state and federal employ. From the standpoint of both farmer and manufacturer the state agricultural experiment station would be the logical agency to conduct such tests as would be necessary to establish the duty of the various sizes and types of implements and machines. Under the direction of station engineers, working closely with the engineers of the equipment companies and with farmers, the results of such trials would bear the stamp of authority acceptable to all concerned.

Good Plowing the Answer

"IF GOOD plowing continues to be considered an adequate method of corn borer control, farmers may be very fortunate."

The foregoing is the very first sentence of a bulletin just issued by the Ohio State University agricultural extension service. The authors are C. O. Reed and E. A. Silver of the department of agricultural engineering of that institution.

The sentence quoted is immediately followed by this one: "By a little more attention to plows and to the art of plowing, they (the farmers) may avoid the necessity of more expensive and less easily applied methods of control."

Such a statement coming from recognized authorities on corn borer control should be very reassuring to the farmers of the corn belt faced with the corn borer menace. Good plowing may not be the complete solution of the control problem, but it would seem to be of paramount importance.

It is no exaggeration to say that farmers of this country have done a lot of slip-shod plowing. Perhaps after all the millions of dollars it is costing the nation and corn belt farmers to fight the European corn borer will be well spent, if it results in better plowing and other improved practices.

More Engineering

OUT of the maze of conversation, speechmaking, investigations, and so on about the so-called predicament of agriculture one thing stands out clearly—to those who get out into the highways and byways of the agricultural communities and observe what is actually going on. Strange as it may seem, it is this particular thing that excites the least comment from most of the politicians, news writers, and would-be farm leaders.

We have reference to the extensive application of engineering that is going on in agriculture. Never before have farmers bought in such large volume tractors, trucks, machinery of all kinds, building materials and equipment, and installed lighting, power and other facilities for reducing power and labor costs in farming operations and for raising the standard of farm living. All this is the product of engineering achievement.

While there is still room for a tremendous amount of engineering in agriculture, an almost unbelievable advance has taken place in the past five years. It is destined to have a profound influence on the future of agriculture, both as a business and as a mode of living. Just what the result a few years hence will be no one can forecast with any degree of certainty, but it is clear that changes of far-reaching importance are impending. Agriculture is apparently entering a period of development perhaps not greatly dissimilar to that which started in the manufacturing industries fifty years ago.

The great trend in agriculture today is obviously toward more and more engineering. The result will be to eventually place agriculture on a par with other industry and with other business, a thing that will undeniably be to the best interests not only of the people in agriculture, but also of all people in any way dependent on agriculture—and that, of course, includes the entire human family.

In this development the agricultural engineer is playing an important part, and he will play an even more important one as time goes on. Back of the service he is expected to render lies a great responsibility, for the evolution of the new agriculture will be largely an engineering achievement. The agricultural engineer gladly accepts the responsibility.

Who's Who in Agricultural Engineering

T. E. Hienton

G. W. McCuen

D. Scoates

F. A. Wirt

T. E. Hienton

Truman Edward Hienton (Mem. A.S.A.E.), as associate agricultural engineer of the Purdue University Agricultural Experiment Station, is project leader in rural electrification in Indiana. A graduate of the agricultural engineering department of Ohio State University in 1921, he was in the agricultural engineering extension work of the University for a short time. From Ohio he was called to Nebraska to continue his extension work in agricultural engineering. After a little more than two years there, he accepted a similar position at Purdue University in 1924. When Indiana planned its rural electrification project he was chosen to direct it and began work in his present position January 1, 1925. While at Nebraska and later at Purdue, he took leave when possible to study at Iowa State College. He was awarded his bachelor's degree in agricultural engineering by that institution in 1926. Under his direction the Indiana rural electrification project has been the source of much valuable information on the application of electricity to agriculture and has stimulated the increased interest of both the farmers and the power companies. An original part of his program is the short course held at Purdue for rural electric service men of light and power companies.

G. W. McCuen

Glenn William McCuen (Mem. A.S.A.E.) is professor and head of the department of agricultural engineering at Ohio State University. Raised on a farm in Illinois, he saw the opportunity for engineering in agriculture before the University of Illinois offered special training in that line. He prepared himself by taking three years of mechanical engineering and two years of agriculture, receiving a bachelor's degree in agriculture from the University of Illinois in 1915. Between his third and fourth years at the University he spent three years as draftsman for various companies. Since his graduation the agricultural engineering department of Ohio State University has claimed him, first as instructor, later as assistant professor, professor, and, since 1924, as head of the department. In addition to his teaching and research achievements, he is the inventor of the Ohio recording belt dynamometer. Tests with this dynamometer are the basis of his article, "Some Power Studies Through the Use of the Ohio Recording Belt Dynamometer," published in AGRICULTURAL ENGINEERING (Vol. 5, No. 3, March, 1924). He has served on the Tractor Rating Committee, the Power Farming Committee, as chairman of the Left-Hand Plow Investigation, and in 1922 as first vice-president of the Society. At present he is chairman of the Committee on Row Crop Management.

D. Scoates

Daniels Scoates (Mem. A.S.A.E.) is professor and head of the agricultural engineering department at Texas Agricultural and Mechanical College. He studied civil engineering, receiving his bachelor's degree from Iowa State College in 1910. While still a student, however, he became interested in agricultural engineering and affiliated with the American Society of Agricultural Engineers in 1909. Upon graduation he accepted a position as assistant agricultural engineer at Montana State College but was soon called to the Mississippi A. and M. College to be professor and head of the agricultural engineering department there. Continuing his studies, he was awarded his professional degree in agricultural engineering by Iowa State College in 1915. In 1919 he accepted his present position. Well known as author of several laboratory manuals on agricultural engineering subjects and of numerous contributions to the farm press, he is now consulting editor for a series of agricultural engineering books being published by the McGraw-Hill Book Company. He is also co-author of the first book of the series, entitled "Land Drainage and Reclamation," which is reviewed in this issue. In the Society he was president in 1918, and more recently, chairman of the College Division.

F. A. Wirt

Frederick Alfred Wirt (Mem. A.S.A.E.) is advertising manager of the J. I. Case T. M. Company. He graduated from the University of Nebraska in 1913 with a bachelor's degree in civil engineering, having specialized in the agricultural phases of the work. His professional biography includes holding positions as assistant professor in charge of the farm machinery department, Kansas State Agricultural College, 1913-17; manager of the publicity department, John Deere Plow Company, of Kansas City, Missouri, 1917-18; agricultural engineering extension specialist and head of the department of agricultural engineering, University of Maryland, 1918-19; assistant sales manager, Emerson-Brantingham Implement Company of Harrisburg, Pennsylvania, 1920-21; professor and head of the agricultural engineering department, University of Arkansas, 1921-22; editor of "Case Eagle," J. I. Case T. M. Company, 1922-24; and his present position since 1924. He is also author of a laboratory manual on farm machinery and of numerous valuable contributions to trade papers and to AGRICULTURAL ENGINEERING. In addition to various committee appointments he was a member of the Council in 1921 and 1922, chairman of the Farm Power and Machinery Division in 1924-25, and president of the Society in 1926-27. At present he is chairman of the Committee on the Bureau of Agricultural Engineering.

A. S. A. E. and Related Activities

Strahan New Chairman Structures Division

DUE to the fact that he is leaving the University of Wisconsin about January 1 to become associated with the Atlas Powder Company, John Swenehart recently resigned as chairman of the Structures Division of the American Society of Agricultural Engineers. To fill this vacancy President Boss has appointed J. L. Strahan, agricultural engineer, in charge of the ventilation department of Louden Machinery Company, who has been serving in the capacity of vice-chairman, as the acting chairman of the Division.

Southwest Section Elects Officers

F. R. JONES, Texas A. & M. College, was elected chairman of the Southwest Section, American Society of Agricultural Engineers, for the year 1929, in the recent balloting of the section. Other officers selected to serve with him are H. T. Barr, University of Arkansas, first vice-chairman, R. W. Baird, Oklahoma A. & M. College, second vice-chairman, and E. N. Gatlin, Texas Power and Light Company, secretary-treasurer. Because it will be host to the Society at the 23rd annual meeting of the Society at Dallas in June, the leadership of the section for 1929 is particularly important.

Agricultural Engineers Head Training Department

OF PARTICULAR interest and significance to the agricultural engineering profession is the training department being organized by the Caterpillar Tractor Company. This department is headed by H. H. Sunderlin, assisted by F. P. Hanson and J. F. Goss, three well-known A.S.A.E. members. Their work consists in conducting tractor schools, dealer training courses, and maintaining instruction at the factory for the company's representatives, salesmen, and service men. Twice each year a ten-day military school will be conducted for reserve officers of the U. S. Army. The organization of this department indicates an appreciation by the company of the benefits to be derived from the proper education and training of those interested in its products.

American Standards Association Succeeds American Engineering Standards Committee

UNANIMOUS approval by the thirty-seven member bodies of the establishment of the American Standards Association to succeed the American Engineering Standards Committee, is announced by William J. Serrill, assistant general manager of the United Gas Improvement Company of Philadelphia. Mr. Serrill was chairman of the Standards Committee, and now becomes president of the American Standards Association. One of the most important results of the abandonment of the committee form of organization will, according to Mr. Serrill, be a much greater degree of participation by trade associations in the direction of the national industrial standardization movement.

One of the first acts of the Association will be the organization of a board of directors composed of twelve industrial executives. This newly created board, which was established in recognition of the increasing part which executives are playing in the standardization movement, will control the general administration and policies of the Association. The old Main Committee, made up of representatives of all the member-bodies, now becomes the Standards Council, and in its hands will rest all matters connected with the adoption and approval of national standards.

The officers of the Association are, in addition to Mr. Sorrill: vice-president, Cloyd Chapman; secretary, P. G. Agnew; and assistant secretary, F. J. Schlink. The advisory committee of Industrial Executives includes: J. A. Farrell, president of the U. S. Steel Corporation, chairman; George B. Cortelyou, president of Consolidated Gas Company; John W. Lieb, senior vice-president of New York Edison Company; L. F. Loree, president of the Delaware & Hudson Company; and Gerard Swope, president of the General Electric Company.

The American Engineering Standards Committee was organized in 1917 by the American Society of Civil Engineers, the American Institute of Mining Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, and the American Society for Testing Materials. The purpose of the organization was to provide a method of cooperation which would prevent duplication in standardization work and the promulgation of conflicting standards. The United States Government Departments of War, Navy and Commerce became members of the committee in 1919. New members were from time to time added until at the time of the present reorganization there were 37 member-bodies. There are in addition 350 sustaining members, including manufacturers, distributors, associations, etc.

Personals of A.S.A.E. Members

W. T. Ackerman, electrical project director and engineer, New England Rural Electrification Project, is author of a bulletin, entitled "Building an Electric Dairy Cold Storage," (Extension Circular 85) recently issued by the Extension Service, University of New Hampshire, Durham.

Greta Gray, formerly professor of home economics, University of Nebraska, is author of Nebraska Agricultural Experiment Station Bulletins 225 and 226. "The Lighting of Nebraska Rural Homes by Kerosene and Gasoline Lamps," is the title of bulletin 225 and "The Nebraska Farm Kitchen," is the title of bulletin 226.

L. E. Hazen, head of the agricultural engineering department, Oklahoma A. & M. College, Stillwater, is author of Circular No. 74, entitled "The Oklahoma Farmstead," just issued by that station.

L. F. Livingston, extension specialist in agricultural engineering, Michigan State College, will address the American Society of Agronomy at its next meeting in Washington on the subject "Marl Digging Machinery."

Geo. W. Kable, formerly agricultural engineer of the Oregon Committee on the Relation of Electricity to Agriculture and the Oregon Agricultural Experiment Station, is the author of two technical reports of particular value to electric light and power companies. One deals with the development of farm service by electric power companies, giving suggestions for the development of rural service, based on a careful study of existing rural service organizations, and on personal observations and experiences of the writer. The other report deals with records for filing for rural departments of electric power companies.

R. W. Trullinger, assistant in experiment station administration (agricultural engineer), Office of Experiment Stations, U. S. Department of Agriculture, presented a paper entitled "Promising Lines of Agricultural Engineering Research," before a meeting of the Association of Land Grant Colleges and Universities held in Washington, D. C., last month. He is also author of a paper, entitled "Progress in the Study of Soil Hydromechanics," contained in the 1927 Report on the Agricultural Experiment Stations. This paper has been reprinted in pamphlet form and copies may be secured from the Office of Experiment Stations, Washington.

C. S. Whitnah recently resigned as manager of the engineering department of the King Ventilating Company to become associated with the Western Steel Products Company, Duluth, Minnesota, as agricultural engineer in charge of the development of products of sheets and steel for farm use.

W. C. Wood recently resigned as instructor in agricultural engineering, University of Saskatchewan, to accept a posi-

tion as field research engineer with the Massey-Harris Company, Ltd., of Toronto.

Index to Agricultural Engineering

AN INDEX to Vol. 9 (1928) of AGRICULTURAL ENGINEERING, the journal of the American Society of Agricultural Engineers, is now available and copies may be had upon request from the office of the Secretary. Copies of the index are being enclosed with copies of this issue sent to members and other regular subscribers of AGRICULTURAL ENGINEERING.

New A.S.A.E. Members

James C. Cherry, planter, Dockery, Miss.

Walter D. Ellison, assistant drainage engineer, U. S. Department of Agriculture, Fort Wayne, Ind.

Ernest B. Kellogg, farmstead engineer, National Lumber Mfgs. Ass'n., New York, N. Y.

Charles A. Logan, research engineer, Colorado State Agricultural College, Fort Collins, Colo.

Erling Styri, professor, The Norway College of Agriculture, As, Norway.

Harold G. Wilson, engineer, Timken Roller Bearing Co., Chicago, Ill.

Transfer of Grade

D. Cromer Heitshu, assistant agricultural engineer, Virginia Agricultural Experiment Station, Blacksburg, Va. (Junior to Associate Member.)

Applicants for Membership

The following is a list of applicants for membership in the American Society of Agricultural Engineers received since the publication of the November issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

John S. Bird, president, Wheat Farming Company, Topeka, Kan.

Allan B. Campbell, electrical engineer, National Electric Light Association, New York, N. Y.

Ben W. Faber, agricultural engineer, Westinghouse Electric & Mfg. Company, East Pittsburg, Penna.

Roy W. Gifford, general superintendent of factories, Massey-Harris Co., Ltd., Toronto, Canada.

Charles T. Gilliam, assistant commercial manager, Central Power and Light Company, San Antonio, Tex.

Joseph H. Godfrey, director of research and publicity, The Creamery Package Mfg. Company, Chicago, Ill.

James H. McAfee, salesman, Advance-Rumely Thresher Co., New Castle, Penna.

John A. Mirtoff, director of Russian Bureau of Agricultural Information, Agricultural Academia in Moscow, U.S.S.R.

C. M. Roan, vice-president and secretary, Self Kleen Thresher Screen Company, Minneapolis, Minn.

Lawrence O. Russell, salesman, J. I. Case Threshing Machine Co., Kansas City, Mo.

Harold M. Ware, member of commission to organize Demonstration State Farm in North Cauvasus, Zerno Trust, Kuznetski Most, Moscow, U.S.S.R.

Ralph Kenneth Wilson, district distribution engineer, Illinois Power and Light Corporation, Du Quoin, Ill.

Raymond H. Bamer, superintendent of live stock, New York State College of Agriculture, Ithaca, N. Y.

Ralph W. Moltke, promotional engineer, Central Illinois Light Company, Peoria, Ill.

Transfer of Grade

John B. McCormick, student trainee, J. I. Case Threshing Machine Co., Racine, Wis. (Student to Junior Member.)

Norman W. Wilson, graduate assistant, Ohio State University, Columbus, Ohio. (Student to Junior Member.)

A.S.A.E. Employment Service

ATTENTION is called to the fact that the employment service conducted by the American Society of Agricultural Engineers, and appearing on this page under the title "Employment Bulletin," is primarily for the benefit of Society members. The members pay annual dues of $8.00 to $15.00, depending on the grade of membership, which help to maintain the employment and other services rendered by the Society. Obviously it would be unfair to make the employment service available to other than members, except, of course, those who seek to secure men for positions for which Society members would be logical candidates.

The availability of this service to members and to prospective employers is clearly set forth on this page in the paragraph in small type directly underneath the heading "Employment Bulletin." Attention is also called, in that paragraph, to the fact that hereafter notices will be inserted for one month only, unless requests for additional insertions are received.

Employment Bulletin

An employment service is conducted by the American Society of Agricultural Engineers for the special benefit of its members. Only Society members in good standing are privileged to insert notices in the "Men Available" section of this bulletin, and to apply for positions advertised in the "Positions Open" section. Non-members as well as members, seeking men to fill positions, for which members of the Society would be logical candidates, are privileged to insert notices in the "Positions Open" section and to be referred to persons listed in the "Men Available" section. Notices in both the "Men Available" and "Positions Open" sections will be inserted for one month only and will thereafter be discontinued, unless additional insertions are requested. Copy for notices must be received at the headquarters of the Society not later than the 20th of the month preceding date of issue. The form of notice should be such that the initial words indicate the classification. There is no charge for this service.

Men Available

AGRICULTURAL MACHINE DESIGNER, age 38, seeks larger opportunity. A graduate in mechanical engineering, with five years of machine shop practice and mechanical drafting, and ten years in experimental department of a large agricultural implement organization manufacturing a full line of tillage and harvesting tools. Experience at bench, floor, field work and drafting. Capable of handling men. MA-155.

AGRICULTURAL ENGINEER, 1928 graduate of Ohio State University, specializing in farm structures, desires connection. Two years experience as extension office under-graduate assistant, devoting time almost entirely to structures work, also one year as full-time extension specialist, before graduation. MA-156.

Positions Open

AGRICULTURAL ENGINEER wanted in sales promotion division of an internationally known tractor company. Young man just out of college last June and with two or three-months' experience in the field preferred. Work will include compiling field data for use in sales work, the handling of demonstrations and fair exhibits, and the other usual work connected with sales promotion. Privilege of starting the work any time between now and the first of January. PO-145.

ENGINEER with designing and drafting experience on combines, threshers and tractors, wanted by a progressive farm machinery manufacturer in the Middle West. Only men with first-class experience need apply. PO-146.

AGRICULTURAL ENGINEER wanted by an Agricultural College in the East as instructor in farm motors and machinery with some opportunity for research work. PO-147.

AGRICULTURAL ENGINEER wanted to teach farm drainage, surveying to forestry students. With summer work the job will pay $2800.00 to $3000.00. PO-148.

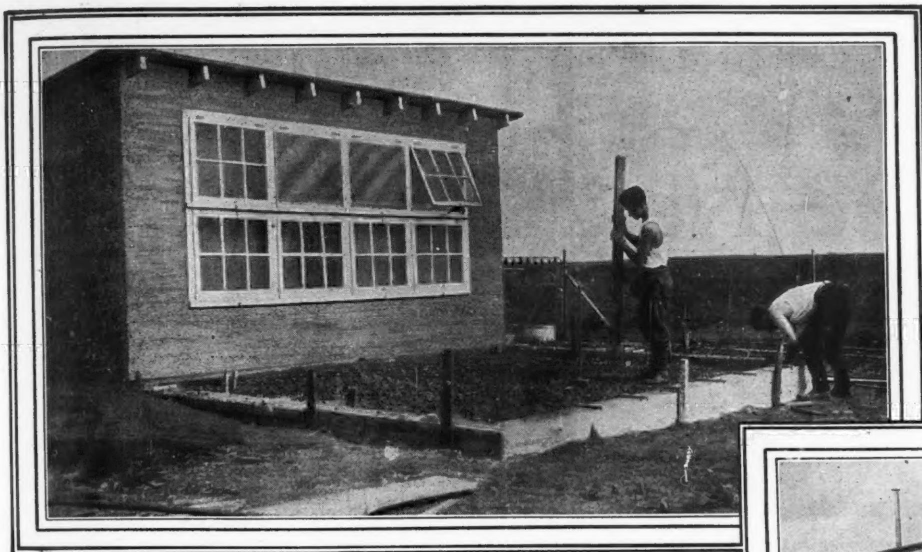
MECHANICAL SUPERINTENDENT wanted by large Canadian manufacturer of farm implements located in Ontario. State present salary, age, and qualifications in detail. Replies strictly confidential. PO-149.

MECHANIC wanted by large Canadian manufacturer of farm implements located in Ontario. Must be first-class man and familiar with experimental work. PO-150.

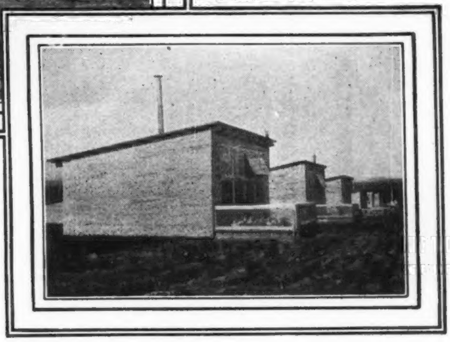
AGRICULTURAL ENGINEER, graduate of Mississippi A. & M. College and North Carolina State College of Agriculture, desires position in college work, either teaching, extension, or research. Has had teaching and extension experience for a period of nine years in southern agricultural institutions and for the past two years has handled work in drainage, irrigation, water supply and plumbing, machinery, building and repair work on a large demonstration farm in the South. MA-157

U. S. CIVIL SERVICE OPENING

The U. S. Civil Service Commission announces an open competative examination for junior agricultural engineer ($2,000 a year). Service may be either in or outside of Washington, D. C. This is an assembled examination covering general physics, mathematics, general engineering, and one optional subject. Applicants should secure and execute form 2600, stating the exact title of the examination and optional subject desired. Applications should be on file with the Civil Service Commission at Washington, D. C., not later than January 22.



Laying the concrete platform for chickens is a simple and inexpensive job.



Now
Sun Porches for Chicks

THE illustration above features a concrete platform, appropriately called a sun porch for chicks. This new development in brooding has been pronounced practical by New Jersey and New England poultrymen after two years of experience.

The pavement protects the health of growing chicks by keeping them off contaminated ground during their first few weeks when they are most susceptible to coccidiosis, black head and intestinal worm infection—profit-taking diseases commonly spread in droppings. On such platforms the chicks get more direct sunshine than is possible when they are confined to the house. The congestion within the house is relieved and the birds gradually become accustomed to outdoor air so that the change from the constant heat of the brooder stove is less abrupt.

Since the platform can be cleaned thoroughly, the poultryman is saved the expense of continually moving the house and yard to new, unpolluted surroundings—an essential sanitary practice where chicks are allowed to run on the ground. When chicks are 6 or 8 weeks old and are released they are large enough to range and may be fed at some distance from the house so that the danger of contracting these profit-killing diseases is largely averted.

PORTLAND CEMENT *Association*

Concrete for Permanence **CHICAGO**

Increase Profits by decreasing costs – *with harvesters that ask no wages*

THE U.S. Department of Agriculture finds an average cost of 70c to produce one bushel of corn; $1.19 for wheat; 54c for oats. Farmers, who are making money nowadays, say stock-tight fences cut production costs by saving labor; making livestock pick the corn, save the storm wrecked grain, save crops skipped by harvesters—and, at the same time, fertilize the soil.

"My farm produces 1/3 more per acre since stock-tight fences made it possible for me to fertilize the soil," writes J. W. Scott, of Jamestown, Ind. "Even the boss will miss some corn. Two men were husking 6 rows each. One got 44 bushel, the other 34. Field not fenced, it could not be pastured. 10 bushels of corn dead waste in every 6 rows." writes H. C. Grundy, Morrisonville, Ill.

RED BRAND FENCE

"Galvannealed"—Copper Bearing

helps many thousands of farmers get bigger yields. D.W. Aeschbacher, Fortuna, Mo., sowed 4½ acres to clover, then turned in 26 shoats to fatten. He mowed 5 loads for hay in June. Mowed again later and threshed out $66 in clover seed. Sold his shoats at $20.00 each. Extra profits, with little labor, all from 4½ acres well fenced.

RED BRAND FENCE is the kind that increases profits by decreasing costs, year after year, for many years. RED BRAND FENCE lasts longer than ordinary galvanized fence because of copper mixed in the steel. A heavier zinc coating "Galvannealed" on the outside resists rust better than any method ever used in making fence wire. Full length, picket-like stays and wavy strands help hold it straight and firm; can't-slip knots hold it tight. This easy-to-erect, good-looking, hog-tight, bull-proof fence makes diversifying crops and stocks easier and cheaper.

There is a good dealer near you who can show you this full gauge, honest weight RED BRAND FENCE.

What has been your experience with good fences? We will pay $5.00 or more for each letter we use. Write for details, catalog and three interesting booklets that tell how others have made more money with hog-tight fence.

KEYSTONE STEEL & WIRE COMPANY
9450 Industrial Street Peoria, Illinois

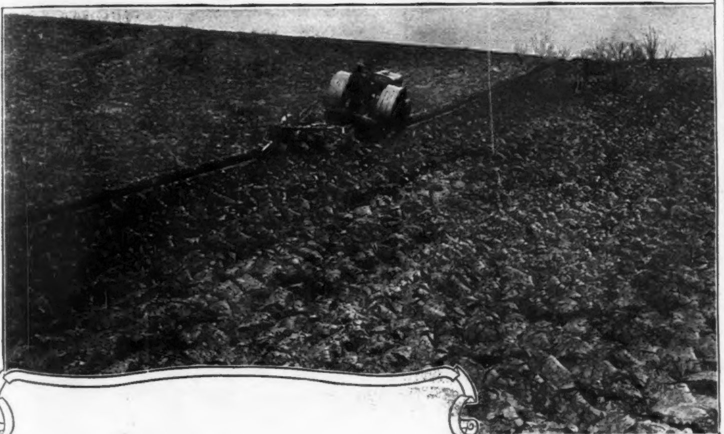
36

Farm paper advertisements like this, appearing in all the leading state farm papers, are teaching farmers about the extra profits to be made from more and better fence. You are invited to write to the Keystone Steel & Wire Company, 9450 Industrial St., Peoria, Illinois, for farm fence evidence that farm extension workers have found interesting and profitable reading. A study of this literature will make you better equipped than ever to advise intelligently on farm fencing problems. There is no obligation of any kind connected with this offer.

KEYSTONE STEEL & WIRE COMPANY

9450 INDUSTRIAL ST. PEORIA, ILLINOIS

Surplus Power

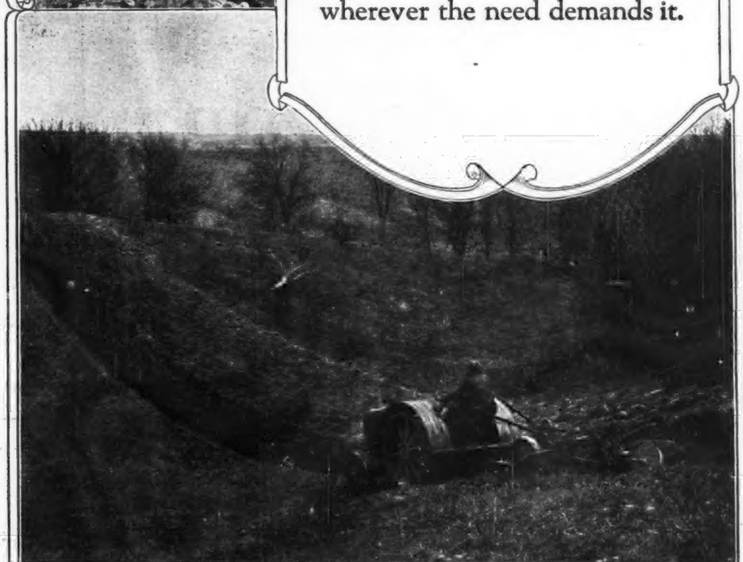


When emergencies arise—when extra power beyond the normal requirements is needed to carry on, there's a big reserve available in the John Deere.

A mere pull on the throttle and there is a surge of hidden power that comes to the front . . . . . for use at drawbar or belt . . . . . whenever and wherever the need demands it.

Combining as it does, this surplus power with extreme simplicity . . . . . with long life . . . . . with fuel, oil and upkeep costs that are unbelievably low—there are sound reasons why the popularity of the John Deere Tractor for farm work has spread far and wide.

In the hilly lands of New England, in the cotton and rice fields of the south, in the orchards on the Pacific coast, in the corn and wheat sections of the middle west, the John Deere has proved its worth on farms.



JOHN DEERE
MOLINE, ILLINOIS

JOHN DEERE MOLINE, ILL. THE TRADE MARK OF QUALITY MADE FAMOUS BY GOOD IMPLEMENTS

And NOW . . . the Horseless Farmers of America!

THE degree of success reached in the application of mechanical power to agriculture is evident in the fact that International Harvester has tabulated several hundred men who are farming entirely without horses. The text of a farm press announcement on the subject, listing the first 200 names, is reproduced here.— *International Harvester Company of America, Inc.*

ON this page we are publishing the names of 200 *horseless* farmers, men who have disposed of their last animal power and are successfully handling their farm work, from start to close of the year, by mechanical power alone — by McCormick-Deering tractor power.

The experience of these men has prompted them to cut loose completely from methods that have prevailed for generations. They are taking *full* advantage of the capacity, the economy, and the wide range of usefulness in mechanical power. They ride by automobile, haul by truck, use a small engine on the light jobs, and the tractor on field and heavy belt work. They are pioneers — *leaders* — in the new age of power farming.

Note the variety in this list as evidence of what can be done with tractor power. These 200 horseless farmers are *an every-day working demonstration* that whatever the type of farm, whatever its size, whatever the section or crop, the high-grade tractor provides the all sufficient power to carry on every operation in every season.

We want to make the roll call of McCormick-Deering horseless farmers as complete as possible and are adding new names to it every day. We hope the readers of this page will help us to build the list and keep it an accurate one. Many farmers whose main dependence is on tractor power still support two or three horses, using them at odd jobs only a few days a year. These men do not quite belong, but as they sell their last horses to benefit from the efficiency of McCormick-Deering tractor power, they will qualify. We will enroll them as fast as we get the information and publish the names from time to time. It is an honor to be listed among the *Horseless Farmers of America*.

First List of Horseless Farmers

Name	Address	Acres	Type of Farming
A			
E J Adams	Crescent, Okla.	80	Wheat, Hay, Corn
C F Amison	Hargill, Tex	240	General
Arthur Andersen	Danevang, Tex.	80	Cotton, Corn
Hans T. Andersen	Danevang, Tex.	133	Cotton
A J Anderson	Lyford, Tex	300	Cotton
V. M. Anderson	El Campo, Tex.	75	Cotton
Visbeck Anderson	Danevang, Tex	100	Rice
Henry Askey	Decatur, Tex.	800	Grain Corn
Richard Austin	Metropolis, Ill.	94	General Orchard
B			
Roy Bain	Newkirk, Okla.	160	Corn, Wheat
J A Banfield	El Campo, Tex.	160	Cotton, Rice
John Bard	El Campo, Tex.	125	Corn, Cotton, Cane
Luther Bard	El Campo, Tex	100	Cotton
Max Barsch	Three Rivers, Tex	120	Cotton, Corn
Geo Bauer	El Campo, Tex	200	Cotton, Corn
Becker Bros	Hackettstown, N J.	450	Grain, Corn
Howard Benton	Horcatur, Kans	600	Wheat, Corn
Berghud & Benson	Hebbronville, Tex	730	Row
Elmer Bergstrom	El Campo, Tex	225	Cotton
Leland T Betry	Bronson, Kans.	60	Row Crop
Leo Bodungen	Hahn, Tex	175	Rice
Booth Bros.	Laplant, S. D.	1250	Grain
Samuel Bosanko	Leola, S D	500	Small Grain
Brady Bros.	Southampton, N Y	48	Potatoes, Wheat
Wm Braun	Mellette, S D	480	Wheat, Clover
M S Brecheisa	Welda, Kans.	900	Corn, Wheat, Oats
W E Bryan	Firstview, Colo.	640	Grain
John Burstrom	El Campo, Tex	160	Rice
C			
D J Carrison	Bolingbroke, Ga	303	Wheat, Soy Beans
A. L Casper	Edna, Tex	126	Corn, Cotton
Ralph Chamberlain	Mobridge, S D.	1300	Small Grain
D U Cheney	Spring Hill, Kans.	41	Sheep, Poultry
Martin Christenson	Richmond, Tex	450	Rice
Churan Bros	Richmond, Tex	500	Rice
B T Clark	Hahn, Tex	170	Rice
G M Cobb	Richmond, Tex	300	Rice
R E Coker	Port Lavaca, Tex	333	Four Row
Percy Coney	Ridgeview, S D	540	Small Grain
Sam Cook	Mabank, Tex	142	Row Crop
Dock Cosper	Edna, Tex	65	Cotton, Corn
Crex Carpet Co.	Grantsburg, Wis	3000	Hay
Harvey Crow	Oakdale, Calif.	1600	Wheat, Barley
Dillard Croxton	La Cygne, Kans.	160	General
G S Crutchfield	Mer Rouge, La.	120	Row Crop
D			
J. F Deems	Burlington, Iowa	200	General
Harry Dickey	Elk River, Minn	400	Potatoes, Etc.
Henry Dornak	El Campo, Tex	130	Cotton, Corn
W T Downs	Oregon City, Ore	60	Mixed
John Duffin	Lisco, Nebr	200	Corn, Grain
T T Duncan	Hahn, Tex.	475	Rice
Duncan & Glass	Hahn, Tex	475	Rice
E			
H A Eckerman	Port Lavaca, Tex.	240	Cotton, Corn
Ekvall and Glass	Richmond, Tex.	900	Rice
L L Ellis	Stafford, Tex	270	Cotton, Potatoes
Earl Erbe	Java, S D	250	Wheat, Corn, Oats
F			
W H Flanagan	Westport, S. D.	360	General
C H Fonda	Aberdeen, S D	640	Grain, Corn, Hay
Robert B. Fonville	Reynolds, Tex	293	Grain, Row Crop
Forrest Frick	Bakersfield, Calif.	430	Cotton
J H Fulmer	Nazareth, Pa.	65	General
G			
Reggie Garrett	Amherst, S D	640	Dairying, Etc.
Frank Gibson	Oakdale, Calif	40	Orchard
T C Gideous	Karnes City, Tex	600	Cotton
Wm Goeltzing	Bowdle, S D	700	Wheat, Flax
H L Grace	Nephi, Utah	500	Wheat
A W Gumm	Long Mott, Tex	400	Cotton
H			
O B Hammon	El Campo, Tex	120	Cotton
Hampton Brothers	Fletcher, Okla	400	General
A W Hanna	Idalia, Colo	800	Wheat, Corn
Harold Hansen	El Campo, Tex	80	Dry Cotton
Henry Hansen	Avoca, Tex	140	Cotton, Corn
John W Harkins	St Francis, Kans	800	Wheat
Clyde Heft	Coldwater, Kans	800	Wheat
Charles Helwig	Miles, Tex	150	Cotton, Corn
Howard Henry	Westhope, N D	1200	Grain
I C Hess	Shiremanstown, Pa	30	Sweet Corn
A Hocksprung	Lasara, Tex	193	Cotton, Truck
Marvin Hollingsworth	Lincoln, Ala	160	Cotton, Corn, Hay
E A Houts	Hargill, Tex	161	Row Crop
F E Howard	Barnard, S D	160	Diversified
J Hubbard	Norwich, Conn	300	Orchard
Eugene & W Huber	Hosmer, S D	200	Wheat, Flax, Etc
Glenn Hunt	Kimball, Nebr	3000	General
J			
Jackson Brothers	Richmond, Tex	700	Rice
Bob Jackson	Carrollton, Mo	100	Wheat
Oscar W Johnson	Lyford, Tex	90	Cotton
J H Jones, Jr	Kibido, Ariz	160	Cotton
R S Jones	Cropwell, Ala		Cotton, Corn, Hay
A Jydstrup	Summit, S D.	380	General
K			
Elmer Kainer	El Campo, Tex.	100	Cotton
Raymond Kainer	El Campo, Tex	140	Cotton
H H Kauth	Harrison, Ark	100	Wheat, Oats
John Kent	Boise, Idaho	168	Grain, Hay
Kent & Colvin	Kenedy, Tex	500	Cotton
Kjos & Brunsdale	Portland, N D	480	Small Grain
M E Kruse	Bishop, Tex	160	Four Row
L			
A Landine	Richmond, Tex	340	Rice
Larson Bros	Richmond, Tex.	460	Rice, Cotton
Richard Lee	Hope, N D.	610	Wheat, Oats, Etc
J A Leisner	Bennview, Tex	160	Dry
Fred Lewer	Raymondville, Tex	300	Cotton, Feed
John Lind	Batesland, S D	2280	Grain
H E Long	Port Lavaca, Tex.	400	Cotton
T H Lurker	Louise, Tex	125	Row Crop
M			
Walter Maedje	Vermontville, Mich.	51	General
Ben Malina	Taft, Tex	157	Cotton
Carl Marty	Oakdale, Calif.	30	Orchard
R O Massey	Edna, Tex	200	Cotton, Corn
Olin Matner	Hemlock, N. Y.	108	Grain, Hay
Phillip Mawhirter	Strasburg, Colo.	960	Grain
Robt. McCreery	Dunstable, Mass.	75	General
Gale L Mercer	Lyford, Tex	96	Row
Henry Mielke	Gordon, Nebr	1040	General
Gerome Mikalos	Benavides, Tex.	170	Cotton, Corn
R. L Milton	La Ward, Tex	160	Cotton, Potatoes
Everett Mosher	Eads, Colo		Wheat, Corn
H S Mullins	Callinam, Tex.	200	Cotton, Grain
Ernest Munkres	Rexford, Tex.	320	Wheat, Corn
N			
Manuel Niems	Duluth, Minn	100	Potatoes, Hay
R. F Nuss	Denver, Colo.	1000	Wheat
Fred Nuttler	Hargill, Tex	400	Cotton
O			
Baker Oglesby	Edna, Tex	130	Cotton, Cane, Corn
Worley M Oldham	Winfield, Kans.	240	Corn, Wheat, Hay
W M Olica	Forbes, N D	600	Small Grain
O Olson	Danevang, Tex	100	Cotton
Emil Opp	Leola, S D	200	Wheat, Flax
B Ostrosenk	Doylestown, Pa.	200	Potatoes
Joe Ourada	Clarks, Nebr	200	Corn
Max Overton	Cache, Okla	230	Grain, Hay, Etc.
G B Owens	Raymondville, Tex	175	Truck, Cotton
Chris Owsuinb	Wendell, Minn	320	Grain, Corn
P			
J F Palmer	Shreveport, La	120	Cotton
C T Peacock	Bovina, Colo	1040	Wheat
Fred W Peaslee	Lancaster, N H.	70	Corn, Potatoes
Vernon Peterson	Danevang, Tex	110	Row
L H Piana	McLaughlin, S D	540	General
E W Poisom	Kenedy, Tex.	125	Cotton, Cane, Corn
P N Prass	La Ward, Tex	80	Truck, Oranges
Leonard Pratton	Java, S D	420	General
M C Putman	Justus, Ohio	158	Corn, Wheat, Hay
Q			
A Quick	Three Rivers, Tex	85	Cotton, Corn, Grain
R			
A H Ramsey	Crandall, Ga	50	Beans
Henry Rasmus	West Point, Nebr	160	General
N W Redwine	Hilje, Tex	250	Cotton
Hughie Reynolds	Lawton, Okla	200	Grain, Row Crop
C J Rhoads	Raymondville, Tex	200	General, Cotton
Frank Richards	Cordele, Ga	320	Row Crop
Roy Roame	Louise, Tex	140	Rice
P L Roche	Pocatello, Idaho	60	Potatoes
Ralph Rule	Bovina, Colo	960	Wheat, Beans
John R Ruther	Artiboy, S. D	480	Grain
S			
Samon Bros.	El Campo, Tex.	600	Rice
E P Scherlin	Edna, Tex.	105	Cotton, Corn
John D. Schlepp	Akaska, S D.	1250	Wheat, Flax, Etc.
Dr. J E Schlottmann	Robstown, Tex.	900	Melons, Cotton
R Schurient	Spalding, Nebr.	240	Corn, Wheat
Walter Scoon	Modesto, Calif.	916	Grain
Seagly Bros	Topeka, Ind.	215	General
John E Shafer	Pierce, Colo.	1280	Wheat
C D Shane	Winfield, Kans.	503	Wheat, Oats
Oscar Shult	El Campo, Tex.	240	Cotton, Corn
Sam Shult	El Campo, Tex.	130	Cotton
Floyd Skiles	Kimball, Nebr.	320	Wheat, Potatoes
Howard Smedley	E. Lansing, Mich.	100	Wheat, Oats, Hay
Gilbert Smelzer	Trail City, S. D.	603	Wheat, Corn, Etc.
F A Smith	Tower City, N D.	1000	Grain
B H Sokolofsky	El Campo, Tex	303	Rice
Sidney Spence	Elm Creek, Nebr.	560	Grain, Corn, Hay
E H Sprague	Waterloo, Nebr.	400	General
J T Stauner	Elgin, Okla	500	Grain, Row Crop
Fred Stephen	El Campo, Tex	160	Cotton, Corn, Cane
E C Stockton	Port Lavaca, Tex.	200	Cotton, Corn
Aug Stoecker	Hosmer, S D	225	Small Grain
C F Stumpff	Lewistown, Pa.	100	General
C Swanson & Sons	El Campo, Tex.	800	Rice, Cotton
C. A Swenson	Kenedy, Tex	200	Row Crop
T			
T J Taylor	Merkel, Tex	170	Row Crop
Bud Thomas	Richmond, Tex.	600	Rice
M Thyssen	Danevang, Tex	80	Cotton
C R Tritt	Kimball, Nebr	2000	Diversified
E H Tucker	Wrightstown, N J	40	Truck
J A Turner	El Campo, Tex	140	Row Crop
W. A Turner & Sons	Salem, N. H.	280	Dairy, Apples
U			
H. B. Utley	Dixon, Ill.	237	Diversified
V			
Warren P Valentine	Line-Lexington, Pa.	68	Potatoes, Corn
Spike Vogel	Kennebec, S. D.	1000	General
W			
W A Waddell, Jr	Oxford, Ala	75	Cotton
Mr Waxman	South Haven, Mich.	150	General
H C Werner	Verona, N. D	700	Grain
N O Westburg	Lyford, Tex	120	Row Crop
Willie Wilbeck	El Campo, Tex.	120	Dry, Row Crop
Herman Wilde	Lasara, Tex	160	Row Crop
F W & P M Williams	Cochran, Ga.	942	General
John Willox	Duluth, Minn.	60	General
J K Wilson	Eagle Pass, Tex.	400	Corn
Raymond Wilson	Kimball, Nebr.	300	Diversified
E M Windwindland	Forbes, N D	300	Wheat, Barley, Flax
Jno Woomtsay	Richmond, Tex.	65	Cotton, Corn
Z			
Arthur Zechman	Bellevue, Ohio	40	Orchard
Henry Ziab	Gothenburg, Nebr.	340	Corn

If you are already farming by tractor power alone or if you know other men who are, please drop us a line about it

INTERNATIONAL HARVESTER COMPANY of America (*Incorporated*)

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McCORMICK-DEERING

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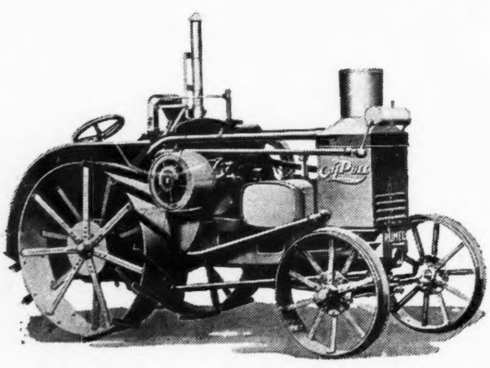
TIMKEN Bearings are used in many important points in the combine harvester and Oil Pull tractor.

Like other prominent manufacturers of farm machinery, Advance-Rumely feels that nothing short of Timken superiority will suffice. Greater load-carrying area, full thrust-radial capacity, safe sealing against dirt, simplicity, low power and lubrication requirements—these are some of the "Timken-Equipped" advantages.

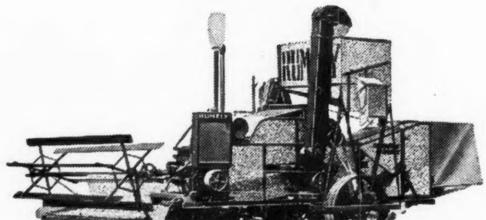
Then, to *preserve* these qualities, is the exclusive combination of Timken tapered construction, Timken *POSITIVELY ALIGNED ROLLS,* and Timken-made electric steel.

The reputations of the world's foremost manufacturers are safely entrusted to Timken.

THE TIMKEN ROLLER BEARING COMPANY, CANTON, OHIO



Oil Pull Tractor, manufactured by the Advance-Rumely Thresher Company, La Porte, Indiana—front wheels Timken-equipped.



Prairie Type Combine Thresher—Timken Bearings front wheels, main wheels, header wheels and fan drive idler.

TIMKEN *Tapered Roller* **BEARINGS**